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## E-Science as a Catalyst for Transformational Change in University Research Libraries: A Dissertation

Mary E. Piorun

*University of Massachusetts Medical School*



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**E-Science as a Catalyst for Transformational Change in University Research Libraries**

A Dissertation presented to the

Faculty of the Simmons College Graduate School of Library and Information Science

In partial fulfillment of the requirements for the Degree of Doctor of Philosophy

By Mary E. Piorun

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# **E-Science as a Catalyst for Transformational Change in Academic Research Libraries**

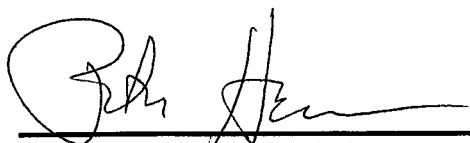
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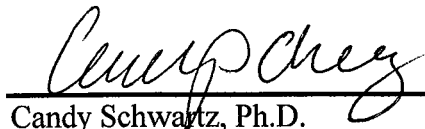
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Date



Ross Harvey, Ph.D.

1-23-2014

Date

# E-Science as a Catalyst for Transformational Change in University Research Libraries

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## Abstract

Changes in how research is conducted, from the growth of e-science to the emergence of big data, have lead to new opportunities for librarians to become involved in the creation and management of research data, at the same time the duties and responsibilities of university libraries continue to evolve. This study examines those roles related to e-science while exploring the concept of transformational change and leadership issues in bringing about such a change. Using the framework established by Levy and Merry for first- and second-order change, four case studies of libraries whose institutions are members in the Association of Research Libraries (ARL) are developed. The case studies highlight why the libraries became involved in e-science, the role librarians are assuming related to data management education and policy, and the provision of e-science programs and services. Each case study documents the structural and programmatic changes that have occurred in a library to provide e-science services and programs, the future changes library leaders are working to implement, and the change management process used by managerial leaders to bringing about, and permanently embed those changes into the library culture. Themes such as vision, team leadership, the role of library

administrators, skills of library staff, and fostering a learning organization are discussed in the context of e-science and leading transformational change. The transformational change included a change in culture, organization paradigm, and redefining the role of the university research library.

## Acknowledgements

I would like to acknowledge my committee, Peter Hernon, Candy Schwartz, and Ross Harvey for their support and faith in me as well as their commitment to reading countless drafts and providing instructive feedback. To Peter Hernon in particular I owe a debt of gratitude for consistently challenging me to become a better writer, student, and researcher.

I would especially like to acknowledge the participants of my study for their willingness to welcome me to their campus, answer my questions, and share their experiences. Please accept my sincere appreciation for the time and perspectives you shared.

My fellow students in the Simmons College Ph.D. in Managerial Leadership in the Information Professions program are the best. My appreciation goes to all of the MLIP students, and especially to those in my cohort. I also wish to thank the staff and faculty at the Simmons College GSLIS program, who were always there to help me.

Working on a doctoral degree is challenging under the best of circumstances. Doing it, while handling a full-time job, requires a strong workplace support system. Thank you to my friends and colleagues at the University of Massachusetts Medical School, Lamar Soutter Library, where I have the opportunity to witness and be a part of our own transformational change under the leadership of Elaine Martin, DA. I send a special thanks to Elaine for her encouragement to pursue the doctoral degree and to Jane Fama for standing (and sitting) by my side throughout this process. The support of the entire library staff has been overwhelming; I appreciate all of your support and encouragement.

I also wish to thank my friends and family who accepted that my absences due to the dissertation were temporary ones and that I would be back in their lives as soon as I was done. I am especially grateful to two new friends in particular that I made throughout this process, Fr.

Charles LeBlanc and Lisa Olson. Fr. Chuck offered me a quiet place to write and countless words of encouragement; Lisa helped me to stay focused on the things in life that really matter. I will never be able to say it enough – to both of you: Thank You.

## Dedication

This dissertation is dedicated to my loving husband Stanley  
for offering me support and believing in my potential before he even knew my name.



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## **Chapter 1**

### **INTRODUCTION TO E-SCIENCE**

In today's highly collaborative, data-driven research environment, roles and responsibilities of university libraries are changing; opportunities abound for the development and provision of unique and valuable services across academic institutions. Consequently, a number of libraries serving universities with membership in the Association of Research Libraries (ARL) have moved beyond the traditional roles of providing access to, organizing, and ensuring the preservation of print-based library resources. Some of these libraries have expanded their role in education to include data management and have seized opportunities to collaborate with faculty and academic departments as they proactively become more involved in e-science (Arms, Calimlim, & Walle, 2009; Choudhury, 2008; Delserone, 2008; Ferguson, 2012; Gabridge, 2009; Gold, 2010; Heidorn, 2011; Johnson, Butler, & Johnston, 2012; Mullins, 2010; Reznik-Zellen, Adamick, & McGinty, 2012).

Terms such as e-research, e-science, cyberscholarship, and cyberinfrastructure are appearing more frequently in the literature of library and information science (LIS) and are often used interchangeably; however, these terms carry different meanings across disciplines, institutions, and countries. E-science, e-humanities, and e-social sciences refer to a specific discipline or a set of disciplines, whereas the term e-research or cyberscholarship is most often employed within the context of all scholarly disciplines (Gold, 2007a; Harvey, 2010). The terms cyberscholarship and e-research, which represent the broadest concept, originated in the United Kingdom. They refer to the "development of, and the support for, advanced information and computational technologies to enhance all phases of the research processes" (Luce, 2008, p. 43).

For libraries that have historically focused solely on managing the traditional outputs of research (e.g., books and journal articles), cyberscholarship, or e-research, offers new opportunities to engage and support researchers throughout the research process as computational technologies make data an important asset and managing those data becomes more challenging (Lougee, 2010).

Cyberinfrastructure, often mentioned in discussions about e-science and e-research, is multi-layered and is comprised of integrated computation and storage systems, software, services, raw data, evidence-based information, published knowledge, social practices, communication systems, institutional and other policies, and personnel (Atkins et al., 2003). According to Atkins et al. (2003), these layers, when working together, provide an “effective and efficient platform for the empowerment of specific communities of researchers to innovate and eventually revolutionize what they do, how they do it, and [determining] who participates” (p. 5). Cyberinfrastructure is more than the physical hardware that constitutes the computing infrastructure or any one tool or resource developed for a particular project, and it cannot be limited to a particular discipline (American Council of Learned Societies, 2006).

Cyberinfrastructure serves as the core on which data-intensive research is built (see Figure 1.1).

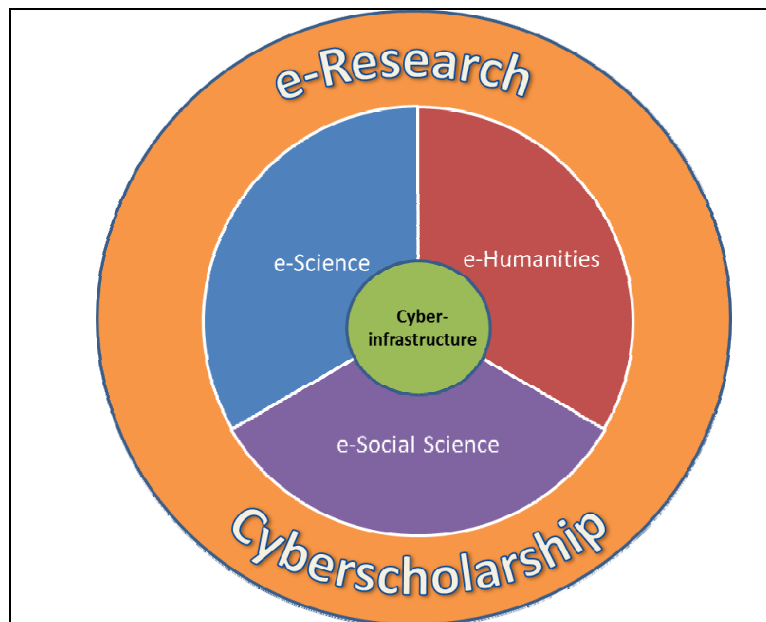
Advances in cyberinfrastructure, such as robust computing power, low storage costs, and the ease with which information can be shared across the Internet, are some of the factors that have transformed the way research is conducted (Hey & Hey, 2006; Johnston & Hanson, 2010; Larsen, 2008; Luce, 2008; Macdonald & Uribe, 2008). Researchers in such fields as genomics, climate modeling, and demographic studies, to name a few, increasingly conduct research using data originally generated by others and frequently access these data in large public databases found on the Internet.

With the aid of these advances in cyberinfrastructure, researchers are collaborating across disciplines and institutions to address research questions and hypotheses that were previously difficult to examine because of the scope, magnitude, and complexity of the topics being studied.<sup>1</sup> In the physical, biological, and medical sciences, large-scale, distributive, computationally intense, and data-driven research is referred to as e-science. Taylor (n.d.) of the UK National e-Science Centre defines e-science as:

Large scale science that will increasingly be carried out through distributed global collaborations enabled by the Internet. Typically, a feature of such collaborative scientific enterprises is that they will require access to very large data collections, very large scale computing resources and high performance visualization back to the individual user scientists. (para. 1)

Figure 1.1

*Term Relationships*



<sup>1</sup> The Sloan Digital Sky Survey is one example of a worldwide project in which over 200 researchers at 150 academic institutions are working together to capture digital images of the universe (<http://www.sdss.org/>).

## **The Concept of Data Defined**

The definition of data varies from discipline to discipline and from researcher to researcher. Individuals assign value to data based on the context in which the data are produced and at what stage of the data life cycle the information exists. Data are, according to one definition, comprised of “facts, numbers, letters, and symbols that describe an object, idea, condition, situation, or other factors” (National Research Council, 1999, p. 15). The Research Information Network (2008) based in the United Kingdom identifies five sources of data:

1. observational: data are captured in real-time and are usually irreplaceable. Examples include sensor data, survey data, sample data, and neuroimages.
2. experimental: lab equipment generates data, which may be reproduced, although it may prove difficult or not cost-effective to do so. Examples include gene sequences and data collected from the large hadron collider.<sup>2</sup>
3. simulation: data are generated from test models (such as climate models and economic models) where the model and metadata are more important than output data.
4. derived or compiled: new data that results from the processing or combining of “raw” or other data sources. Examples include the results of text and data mining, compiled databases, 3D models, or geographical data.
5. reference or canonical: a (static or organic) collection of smaller (peer-reviewed) datasets that are published and curated, such as gene sequence databanks or chemical structures.

During the conduct of scientific inquiry, data are collected, observed, analyzed, or created to produce original research. After they are collected, they undergo various transformations.

---

<sup>2</sup> The Large Hadron Collider (LHC) is a massive underground scientific instrument that spans the border between Switzerland and France, near Geneva. It is a particle accelerator used by physicists to study the smallest known particles of the universe – the fundamental building blocks of all things (European Organization for Nuclear Research, 2008).



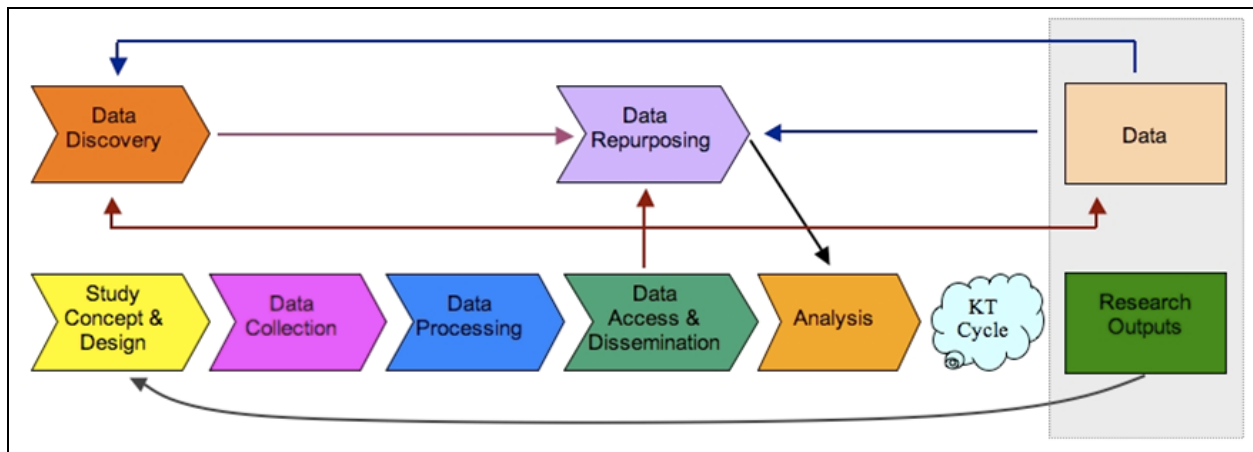
Primary or raw data are data that have not been manipulated or changed by researchers. Once researchers dissect, filter, analyze, or organize primary data, that primary data become secondary or processed data (Tjalsma & Rombouts, 2010).

The data life cycle represents all of the stages of the life of a datum from its creation for a study to its distribution and reuse (see Figure 1.2). The data life cycle begins with a researcher(s) developing a concept for a study; once a study concept is developed, data are then collected for that study's research. The data are then processed for distribution so that they can be preserved and used by other researchers at a later date. Once data reach the distribution stage of the life cycle, they are stored in a location (i.e., repository or registry) where other researchers can discover them. Data discovery leads to the repurposing of data, which creates a continual loop back to the data processing stage, where the repurposed data are preserved and distributed for discovery.

Each of the steps in Figure 1.2 represents a stage in the life cycle. The breaks between sections represent the transitions between phases. In these periods of transition, important information about the data can be lost if there is no forethought given to preserving a snapshot of the data at that point in time. "These transition points become important areas in negotiating the digital curation plan for a project as partners in the life cycle of research identify who is responsible for the digital objects created at each stage" (Humphrey, 2006, p. 4).

Figure 1.2

*The Life Cycle Model of Research Knowledge Creation\**



\* KT stands for Knowledge Transfer and the variety of methods used in communicating research outcomes.

Source: *e-Science and the Life Cycle of Research* by Charles Humphrey, 2006. Reproduced with permission of Charles Humphrey.

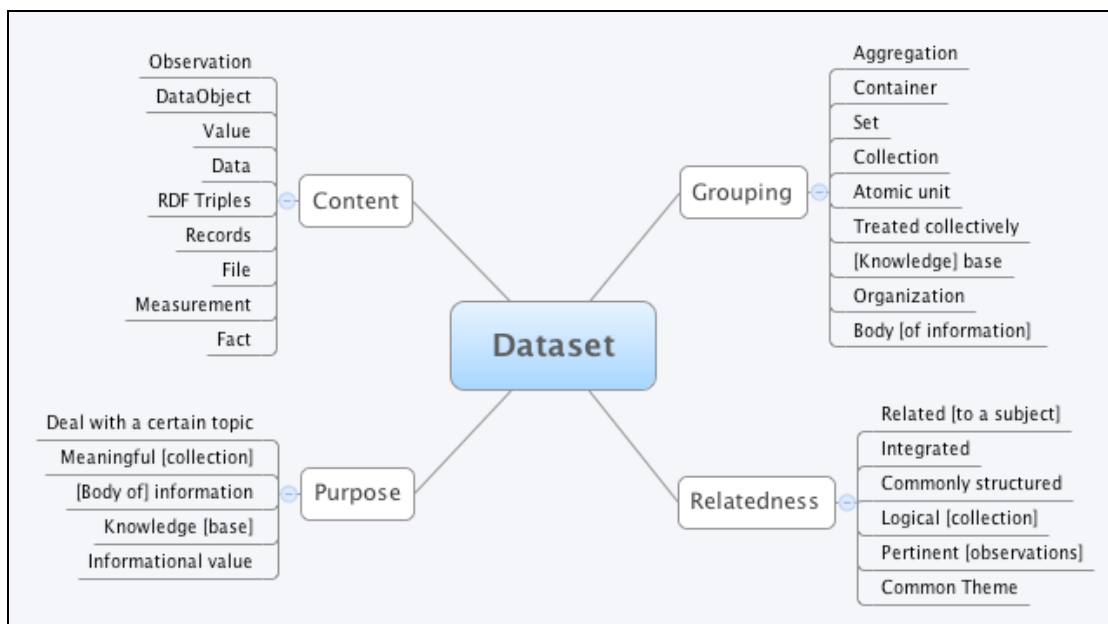
In the professional literature related to e-science and data management, the term *dataset*, which describes collections of data (primary or secondary), is a heterogeneous term that could be made up of any type of collection for any type of data. For example, a dataset may contain multiple files such as raw imaging files, 3D reconstructions, protein sequences, DNA sample data, and a variety of segmentations. Renear, Sacchi, and Wickett (2010) have identified four features of a dataset from the scientific literature (see Figure 1.3):

1. grouping: terms like set, aggregation, container, and collection are routinely used to indicate that datasets are data treated collectively, as a unit.
2. content: the substance of a dataset are things of some particular kind. The data in datasets are variously described with terms such as observations, facts, values, and records of values.

3. relatedness: datasets are thought of as grouping together constituents (data) that are related to each other in some way that goes beyond both the grouping itself and the identification of the grouped things as all being of the same general kind of entity.
4. purpose: datasets are created in order to contribute in some way to scientific activity. This might be by providing evidence to be analyzed, suggesting new hypotheses, providing refutation or confirmation of existing hypotheses, or supplying new phenomena to be explained (Renear et al., 2010).

Figure 1.3

*Conceptual Map of Dataset Features*



Source: *Definitions of dataset in the scientific and technical literature* by Allen Renear, Simone Sacchi, Karen Wickett, 2010. Reproduced with permission of Allen Renear.

Dataset is an important concept in data curation and citation (Borgman, 2012). In regard to curation, the lack of a precise common definition of a dataset that is shared across disciplines can create curatorial problems for multi-disciplinary digital data repositories. These repositories are intended to integrate data from many sources in order to solve real-world multi-disciplinary

problems and must present their resources in a uniform common context (Renear et al., 2010).

Datasets are important to data citation in that researchers are able to identify the individuals responsible for creating the data so that the datasets can be verified for completeness and repurposed for future study. Datasets also facilitate attribution to research data sources to allow for easier access to research data within journals and on the Internet. Having a complete, citable dataset also supports the reuse of data, ensures that researchers remain accountable for their data, and allows researchers to claim credit for developing datasets.

### **Growth of Data**

The data used in e-science are generated as part of the research process or come from existing datasets that previous researchers have made available. In 2009, the amount of digital data in all forms (e.g., quantitative, voice, images, and text) grew 62 percent to 800,000 petabytes<sup>3</sup> (Gantz & Reinsel, 2010); in 2011 it was estimated that this number would reach over 1.8 zettabytes.<sup>4</sup> By 2020, the amount of digital data created, stored, and managed is projected to expand from 2009 by a factor of 50 to reach 40,000 exabytes<sup>5</sup> (or 40 zettabytes) (Gantz & Reinsel, 2012) by 2020. Much of that data will be created from computer processes, applications, or other machines without the intervention of a human. Acknowledging this growth of scientific data, the 2020 Science Group (2005) reports that the immediate challenge for researchers is “end-to-end scientific data management” (p. 8). Data must be managed from the point of creation or acquisition to long-term preservation or disposition and throughout all the activities in-between, such as mining, sharing, and migrating. Sharing is a critical element in data management because reusing research data accelerates the rate of new discovery (Nelson,

---

<sup>3</sup> A petabyte equals one million gigabytes.

<sup>4</sup> A zettabyte equals one trillion gigabytes.

<sup>5</sup> An exabyte equals one billion gigabytes.

2009),<sup>6</sup> avoids the expensive duplication of data-collection activities, facilitates replication and verification of research results, and promotes collaboration (Borgman, 2012; National Institute of Health, 2003).

### **Data Sharing Requirements**

In order to promote data sharing, federal agencies require that research data produced as part of a funded project be made publicly available and/or have instituted requirements for formal data plans. In 2003, the National Institute of Health (NIH) implemented a data-sharing policy for grant proposals of more than \$500,000, and expects data to become available at the same time the findings are published. Although the policy encourages researchers to create data-sharing agreements, and the NIH will provide the funding to create secure data enclaves, the methods of sharing data are up to the researcher and institutional practice. The policy recommends that raw data that will be shared have documentation in the form of codebooks, which explain the data fields and how and when the data were collected; it also specifies identifying any use restrictions (National Institute of Health, 2003). In October 2010, the National Science Foundation (NSF) implemented a policy requiring any new proposal (regardless of size) submitted after January 18, 2011 to include a data management plan in the form of a two-page supplementary document, stating that this was the first step of a more comprehensive approach to data policy (National Science Foundation, 2010). Although the data management policy does not require sharing, researchers are encouraged to make their data publicly available or state why they will not. The data management plans are included in the

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<sup>6</sup> The Human Genome Project (HGP) is a prime example of how early distribution of genomic sequence data have accelerated discovery of new information in areas beyond the original scope of the project. These areas include, for instance, identifying new types of biofuels that can be used as energy sources, discovery of migration patterns through genetic inheritance, and the creation of stronger, more disease-resistant plants and animals (Department of Energy, 2009).

peer review process of submitted proposals, whereas with the NIH sharing policy, the details of the plans are limited to the center or institute's program officer.

Other federal entities, such as the Department of Energy, Department of Agriculture, Centers for Disease Control and Prevention, National Aeronautics and Space Administration, and the Environmental Protection Agency, have also issued guidelines and policies for researchers to follow. The trend continues. On February 22, 2013, the White House Office of Science and Technology Policy (OSTP) issued a Memorandum for the Heads of Executive Departments and Agencies (Holdren, 2013), which calls for federal agencies investing in research and development (more than \$100 million in annual expenditures) to have clear and coordinated policies (within six months) for increasing access to research products (Strasser, 2013). The memo requires that agency plans cover both scientific articles and scientific data.

Data are defined as:

... digitally recorded factual materials commonly accepted in the scientific community as necessary to validate research findings including datasets used to support scholarly publications, but does not include laboratory notebooks, preliminary analyses, draft of scientific papers, plans for future research, peer review reports, communications with colleagues, or physical objects, such as laboratory specimens. (Holdren, 2013, p. 5)

By December 2013 no definite policy has emerged, yet three approaches are gaining ground. The first, put forth by a coalition of scholarly publishers, is named Clearinghouse for Open Research for the United States (CHORUS). In this approach data reside with the publisher and through a series of metadata tags and monitoring of embargo periods scientific research becomes available over time (Ratner, 2013). ARL put forth a competing proposal named the

Shared Access Research Ecosystem (SHARE). In this approach universities (their libraries) build and maintain a series of interlinked institutional repositories in which commercial search engines, such as Google Scholar, provide cross-searching and retrieval (Association of American Universities, Association of Public and Land-grant Universities, & Association of Research Libraries, 2013). A third approach, without any official sponsor, is named “PubFed Central” (Crotty, 2013, para 4), which expands the use of PubMed Central® to all federal agencies.<sup>7</sup>

The Fair Access to Science and Technology Research Act (FASTR), a bill introduced in Congress<sup>8</sup> on February 14, 2013, focuses on published journal articles, often thought of as the finished product of research and not the actual research data generated throughout the process. The bill would require at least 11 U.S. government agencies with annual extramural research expenditures of more than \$100 million to make manuscripts of journal articles stemming from research funded by that agency freely accessible and reusable via the Internet. The Public Access to Public Science Act (PAPS), a bill introduced in the House on September 19, 2013, requires four federal agencies<sup>9</sup> to develop public-access policies that “allow the public to read, download, and analyze by machine covered works in digital form” (“Public Access to Public Science Act,” 2013, 2.b.1). These new potential mandates and policies are prompting a wider discussion about data sharing and management among researchers and other stakeholders in publicly-funded research, including journal publishers. Moreover they are sparking the creation of public data

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<sup>7</sup> “PubMed Central® (PMC) is a free archive of biomedical and life sciences journal literature at the U.S. National Institutes of Health's National Library of Medicine (NIH/NLM). In keeping with NLM's legislative mandate to collect and preserve the biomedical literature, PMC serves as a digital counterpart to NLM's extensive print journal collection. Launched in February 2000, PMC was developed and is managed by NLM's National Center for Biotechnology Information (NCBI) (National Center for Biotechnology Information (NLM), 2011), para 1).

<sup>8</sup> FASTR in the Senate (S. 350) was introduced on February 13, 2013 by John Cornyn (R-TX) and Ron Wyden (D-OR) and introduced in the House (H.R. 708) the same day by Mike Doyle (D-PA), Zoe Lofgren (D-CA), and Kevin Yoder (R-KS). The bill was referred to the House Committee on Oversight and Government Reform, and the Senate version was referred to the Committee on Homeland Security and Governmental Affairs.

<sup>9</sup> The four agencies are: the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), and the National Weather Service (NWS). The bill was referred to the House Committee on Science, Space, and Technology.

repositories based on subject, location, and/or organization<sup>10</sup> (Birney et al., 2009; Doctorow, 2008; Howe et al., 2008; Schofield et al., 2009).

Despite the benefits of sharing datasets, the means to share data are still new, and acceptance of the practice varies by field of study and individual researchers (Birney et al., 2009; Nelson, 2009). Worldwide the process of sharing data can be so confusing that some scientific researchers are limiting themselves to informal distribution options unless mandated by a funding organization (Nelson, 2009). The method of sharing data may be formally specified by a funder's policy or a publisher's requirement, such as creating a separate version of the data that is annotated and in which all personal, identifiable information is removed. Data may also be shared informally among co-authors or co-investigators within the same research group where there is a high level of trust and the risk is perceived to be low (University of Edinburgh, 2009).<sup>11</sup> Some researchers are so concerned about surrendering their data to other researchers before all potential uses are exhausted that they are unwilling to share. Those researchers who are willing to share data must decide which data to distribute and then determine whether there are existing standards that dictate format.

### **Institutional Support for E-Science**

Meeting the needs of researchers working in the highly data intensive environment of e-science requires the appropriate support services, infrastructure, and policies to be in place. Considering the growth of data and pace of change associated with e-science, many research institutions are simply reacting to the data management needs of individual researchers instead of

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<sup>10</sup> Examples of formal subject based data repositories include arXiv.org for physics, mathematics, and computer science; the International Council for Science's World Data System (<http://www.icsu-wds.org/services/data-portal>) for geophysics; and Protein Data Bank (<http://www.pdb.org/pdb/home/home.do>) and GenBank (<http://www.ncbi.nlm.nih.gov/genbank>) for molecular biology.

<sup>11</sup> Informal methods of sharing data include posting files on internal networks, distributing data through e-mail, DVD or CD-ROM upon request, or distribution through social media sites.



taking a systematic approach and providing institutional level solutions. The stages of cyberinfrastructure development present a common set of difficulties whether in a nascent stage of development, in practical deployment and operation, or stabilized as an institution (Ribes & Lee, 2010), and call for a strategic approach:

Campuses are making local CI [cyberinfrastructure] investments ranging from minimal capabilities up through multi-teraflop computational systems with support facilities.

Lacking is the larger goal of developing a coherent, coordinated vision to leverage these capabilities among the individual, campus, and national facilities. (EDUCAUSE Campus Cyberinfrastructure Working Group and Coalition for Academic Scientific Computation, 2009, p. 4)

The development and implementation of university-wide solutions will require the input and participation of a wide variety of institutional entities, including academic departments, computing services, libraries, and the offices of research services; no one office, department, or center will be able to provide everything that is required due to the scale of the issue. Research institutions already have considerable experience in providing a research infrastructure for their constituents, but this expertise must be integrated, built up, and expanded. Researchers are asking questions such as where data will be stored, who owns the data, how to connect and collaborate across institutions and across the world, and who will pay for infrastructure investments. Each research institution must answer these questions based on its local environment and culture. To do so, research institutions have assembled task forces, committees, or working groups with cross representation from various departments on campus to address these issues and offer recommendations for a more strategic approach (Ogburn, 2010).

## **Role of the University Research Library in Providing E-Science Services**

Within the scientific research community, there is an identified need to improve the management of the massive amounts of research data that are generated daily as the research process becomes more technology-based, collaborative, and data intensive (Doctorow, 2008). Recognizing the importance of this issue, the NSF has a cyberinfrastructure vision for the twenty-first century that features goals to support innovation in data management and distribution systems, including the continued development of digital libraries to house scientific data (National Science Foundation, 2007). Some of the challenges that researchers encounter when meeting data management needs are long-term preservation, short-term storage, data sharing, digital rights, copyright, metadata creation, and the creation and availability of user tools (Pritchard, Anand, & Carver, 2005). Successful data management programs are highly collaborative and include participation by researchers, computer scientists, networking specialists, and university administrators, as well as national data centers, funding agencies, and libraries (Friedlander & Adler, 2006).

Libraries at research universities offer expertise and skills to the research community in the selection of resources, metadata creation, preservation, data organization and management, and access management. Some of these libraries are developing data reference and consulting services and are informing faculty and other researchers about the importance of preserving and sharing raw data. A few libraries are involved in the planning phases of research projects, designing data management plans, providing workspace for researchers to collaborate (physically and virtually), and contributing to the development of institutional-level policies regarding data management (Choudhury, 2008; Cornell University Library Data Working Group, 2008; Delserone, 2008; Gabridge, 2009; Johnston & Hanson, 2010; Soehner, Steeves, & Ward,

2010; University of Minnesota Libraries, 2006; Witt, 2008). University research libraries are also developing partnerships by creating and managing long-standing archives, generating policies and programs for open access to scholarly information, and developing user-focused tools for data mining and information discovery (Joint Task Force on Library Support for E-Science, 2007; Mullins, 2007; Steinhart et al., 2008; Walters, 2009).

The ARL Joint Task Force on Library Support for E-Science maintains that university research libraries have an important role in managing and preserving research-generated datasets; however, data management is just one aspect of e-science (Atkins et al., 2003; Pritchard et al., 2005). There is a range of opportunities within e-science for libraries to extend their services (Soehner et al., 2010); however, the extent to which they become involved in other areas, such as developing new tools and services, forming new partnerships, and collaborating with researchers, depends on a commitment from library administration to support this new direction. In order for a library to engage in any e-science program on campus, it must first establish itself as a valued strategic partner (one that can provide physical and/or intellectual resources towards the achievement of a defined common goal) and form good working relationships with faculty and those associated with envisioning the role of e-science or e-research. For libraries that are able to form these new relationships, the ARL E-Science Task Force suggest the results might redefining those research libraries for the future (Joint Task Force on Library Support for E-Science, 2007, p. 5). As Gold (2007b) states, e-science has the potential to both revitalize and transform university research libraries.

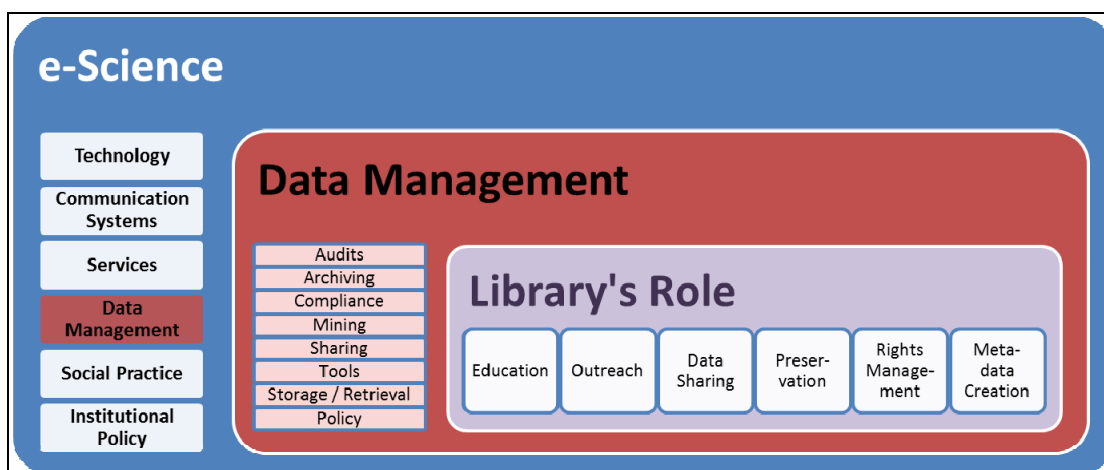
### **Conclusion**

As science becomes increasingly characterized by large-scaled collaborations and computational datasets, researchers face a range of data management challenges and needs.

Librarians can offer researchers at their institutions a range of data management programs and services associated with e-science (see Figure 1.4). Librarians have the opportunity to connect and collaborate in new ways with the research communities within their institutions. Along with actually identifying, curating, preserving, and archiving datasets, and assigning metadata elements, librarians can teach researchers and students about data management fundamentals and assist researchers with writing data management plans. The traditional roles of librarians can be adapted to work in this new data environment; at the same time, they may need to acquire additional knowledge, skills, and abilities. The librarians that fill these research roles may be called e-science librarians, scientific data curators, data librarians, informationists, or embedded librarians (Creamer, Martin, & Kafel, in press). Whatever the title, some university research librarians are already participating in these activities, while others are examining models to best provide a range of research data services. Redefining relationships and assuming new roles will require time and resources. Libraries must determine how e-science services and programs align with the existing mission, vision, and priorities; and then, they must ask what changes are needed.

Figure 1.4

*Library Role in E-Science*



The next chapter describes the study's reflective inquiry, including the methodology employed to address the questions regarding the academic library's role and responsibilities related to e-science. The chapter starts with the problem statement, which sets up the parameters of the study and its originality. The investigator then provides a literature review on the role of academic libraries in developing and providing e-science services. Following this, the research design presents a description of the process the investigator used to determine the institutions to approach as potential participants, along with the case study methodology she used.

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## **Chapter 2**

### **THE STUDY'S REFLECTIVE INQUIRY AND PROCEDURES**

As advances in research benefit from the power of high-performance computing, researchers, with the support of their institution and other service providers, are developing and using new tools and services to manage the resulting abundance of data. The knowledge, skills, and abilities librarians required to facilitate and participate in this data-driven research, go well beyond familiarity with disciplinary literature (Luce, 2008).

Redefining relationships and assuming new roles will require time and resources. It will necessitate reallocating some library resources from the management of traditional collections to engaging with the research community and for librarians to assume new roles as data managers. These types of opportunities, however, will vary from institution to institution based on the extent to which the library participates in and leads them. The senior leadership team of each library must determine how e-science services and programs align with the existing mission, vision, and priorities; and then, they must ask what changes are needed.

#### **Problem Statement**

Many university libraries whose institutions have membership in the Association of Research Libraries (ARL) have a foundation in collaboration, outreach, and knowledge management from which to assist the research community and become contributing partners in departmental and institutional level e-research initiatives. The degree to which these libraries have a role in e-research initiatives at the department and institutional levels and the internal changes implemented to assume that role, however, have not been examined. This study fills that void by exploring how and why ARL universities and their libraries became engaged in one

aspect of e-research, namely, e-science, how e-science was conceived and implemented within such institutions, the structural and programmatic changes that have occurred in the libraries to provide e-science services and programs, and the library leadership necessary to bring about those changes. The intention is to focus on libraries and the support and programs they offer, but within the institutional context.

Research regarding the role of libraries in e-science is timely because many research libraries are seeking to assume a larger role in e-science programs at the institutional level. The results of this study provide those libraries considering the implementation of an e-science program with a greater understanding of how other university libraries are designing and implementing e-science programs and how the institutional context affects these efforts. Moreover, this research raises awareness of the issues associated with realizing e-science programs, such as needed resources and skills, the importance of strategic partnerships, and barriers to change. The study assists libraries considering a role in e-science by showing how to integrate programs and services with existing activities, raising awareness about the types of changes that are needed, and exploring the leadership needed to bring about a successful e-science support program.

Given the interdisciplinary nature of e-science, the findings of this study are also of interest to those working in related areas such as computer science departments, campus computing centers, upper administration, and those studying change management. A successful e-science program is collaborative by nature — each group of potential partners can benefit from learning more about e-science programming and services, and how the library can be a part of those programs. In addition, these findings can be applied beyond e-science--this study's

findings suggest strategies for libraries seeking to support e-research programs in the social sciences and humanities.

## **Literature Review**

### **Libraries and E-Science Support**

The early twenty-first century surge in e-science projects can be linked to increased funding in the biological and physical sciences (Ribes & Lee, 2010). The proliferation of projects has provided an opportunity for university research libraries to form new partnerships, contribute to institutional-level planning and policies, develop new services, and collaborate with other libraries. The majority of studies of e-science activities in libraries consist of reports on ongoing planning (Brant, 2007; Johnston & Hanson, 2010), development, and deployment of related services (Arms et al., 2009; Choudhury, 2010; Denison, Kethers, & McPhee, 2007; Garritano & Carlson, 2009; Soehner et al., 2010; Walters, 2009), or explanations of the concepts of e-science and calls for library involvement (Heidorn, 2011; Hey & Hey, 2006; Joint Task Force on Library Support for E-Science, 2007; Macdonald & Uribe, 2008; Mullins, 2009; Rambo, 2009).

Soehner et al. (2010) provide the most comprehensive report on e-science activities in ARL affiliated libraries to date. The results of their survey of 123 ARL libraries indicate that, in 2009, 44 of 57 respondents support e-science activities or plan to do so. The information gathered from follow-up phone interviews at Purdue University, the University of California, San Diego, Cornell University, Johns Hopkins University, the University of Illinois at Chicago, and the Massachusetts Institute of Technology served as the basis for developing more in-depth case studies to highlight programs and services currently offered by those libraries. The six case studies illustrate that each library is working in a unique culture and environment. Obstacles to developing e-science programming, such as limited resources and skill sets, deciding whether to



hire new staff versus re-training existing staff, and the lack of a unified direction at the institutional level, are some of the barriers faced by the case study libraries.

## Libraries and Data Management

For many libraries a first step in getting involved in e-science has been to take an active role in projects that center around data management and data-related services (Ferguson, 2012; Reznik-Zellen et al., 2012). Libraries involved in data management often started with a service role. For example, a library may offer an introductory non-credit course on data management for graduate students and provide a website with a list of resources to assist students and faculty with data management. Introductory services can lead to the library working with individuals to offer more specialized and customized services. Table 2.1 is a compilation of services related to data management taken from case studies by Choudhury (2008), Garritano and Carlson (2009), and Soehner et al. (2010).

Table 2.1

### *Data Management Services Currently Provided by Libraries\**

Area	Activity
<b>Education</b> (Incorporating data management into library and information science program curricula)	Continuing education for librarians Developing workshops for faculty, students, researchers Supporting data management internship
<b>Policy</b> (commissioning a working group to set standards for scientific datasets)	Advising on policy and procedures Partnering/managing external data compliance Setting metadata standards
<b>Research</b> (for example, the development of the Data Profiles Project at the University of Illinois at Urbana-Champaign and at Purdue University)	Partnering to securing external funding Writing grants

Table 2.1 (*continued*)*Data Management Services Currently Provided by Libraries*

Area	Activity
<b>Services</b> (for example, the Massachusetts Institute of Technology Libraries hosting a data management website for faculty and students)	Applying metadata standards Building institutional repositories (bibliographic and data) Creating permanent URLs Creating digital object identifiers for future referencing Data management planning Developing/modifying controlled vocabularies/content standards Dissemination and discovery of datasets Documenting rights management Facilitating dataset retrieval Facilitating online journal publishing Inventorying and creating a registry of local datasets Participating as a member of the research team Promoting the sharing and reuse of data Providing reference and consultation services

\* Adapted from Gold (2010).

Despite Lewis' (2008) comment that the library's role regarding e-science and data management is secure (p. 51), many libraries see mixed results related to the categories mentioned in the table (Salo, 2010). Partnerships have been formed to write grants, but if the grants are not funded, the partnerships then focuses more on identifying new sources of funding and less on providing services (Soehner et al., 2010). Few libraries have been invited to participate in institutional-level policy making. Faculty are not always receptive to the library's gestures to assist on research projects, and are hesitant to share their data (McKay, 2010). Libraries also confront the challenge of recruiting staff with a mix of computer, subject, and library knowledge to work with data (Joint Task Force on Library Support for E-Science, 2007). However, some libraries have been successful. The case studies presented by Soehner et al.

(2010) identify libraries that have formed new departments specifically designed to develop and provide e-science services. Librarians in these departments are creating new tools for data discovery, analysis, and deposit, and are finding researchers willing to collaborate on e-science related projects (Arms et al., 2009; Choudhury, 2008; Lage, Losoff, & Maness, 2011; Soehner et al., 2010; Zhao, 2009). Some library administrators are redefining the concept of the liaison librarian and opting to embed librarians fully into departments to offer customized services and partnership on research projects (Shumaker & Talley, 2010). Embedded librarians can be assigned to one project on a short-term basis (Carlson & Kneale, 2011), or they can be department-based, where the librarians are hired on a long-term basis to work on a range of projects with varying responsibilities (Oliver & Roderer, 2006).

One way in which libraries are preparing to offer data management service is by gaining an understanding of data management practices among researchers (Tenopir et al., 2011). They are doing this by interviewing faculty and researchers to discuss their information needs (Lage et al., 2011; Witt, Carlson, Brandt, & Cragin, 2009). These studies have shown that different disciplines have unique needs (e.g., confidentiality requirements, the amount of data to be managed, and proprietary formats), which means that libraries need to realize that data management services must be highly customizable and flexible (J. C. Molloy, 2011). As libraries become more involved in data management services, the level of support required and the cost of that support increase (Reznik-Zellen et al., 2012).

Faculty, researcher, and student interviews have also shown a need for teaching data literacy<sup>1</sup> at various education levels and for librarians to be an essential part of that training

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<sup>1</sup> Data Literacy in the sciences can be described as the "knowledge and skills involved in collecting, processing, managing, evaluating, and using data for scientific inquiry. Although there are similarities in information literacy and digital literacy, science data literacy specifically focuses less on literature-based attributes and more on functional ability in data collection, processing, management, evaluation, and use. This emphasis on operational

(Carlson, Fosmire, Miller, & Nelson, 2011; Piorun et al., 2012). Gabridge (2009) points out that “academic communities have a constantly revolving community of students who arrive with ... uneven skills in data management. ... Librarian subject liaisons already teach students how to be self-sufficient, independent information consumers. This role can be easily extended to include instruction on data management and planning” (p. 17). Teaching data management provides libraries with opportunities to extend current instructional services; however, it is important to have a clear understanding of research needs in this area and to possess the knowledge to be effective instructors.

### **Desired Skills and Continuing Education of Library Professionals**

As library professionals carve out their roles in data management, the question arises as to what knowledge, skills, and abilities are needed to develop and provide e-science services and become effective members of research teams. Some librarians describing their experiences working on e-science projects have identified knowledge that they thought would be useful, such as subject expertise and familiarity with current metadata standards (Garritano & Carlson, 2009). However, there are studies that have employed a more systematic approach to identifying the knowledge, skills, and abilities needed for data management. Lankes, Cogburn, Oakleaf, and Stanton (2008) propose the new role of “cyberinfrastructure facilitators (CI-Facilitator),” individuals who foster collaboration between the scientist and the information professional. After analyzing research and technology-focused federal job descriptions and comparing that information with the results of interviews of faculty and students from a variety of science, technology, engineering, and medical fields, they concluded that knowledge of information technology alone would not suffice; specific subject knowledge was also needed. Cox, Verbaan,

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skills coincides with the practice-based production, operation, and use of digital datasets during scientific research” (Read, 2013, Definition).

and Sen (2012) take this one step further to suggest that experience in doing research is also a critical ability:

Librarians often lack direct personal experience of research and so may lack a depth of insight into the motives and practices of researchers. Understanding the diversity of ‘research data’ itself, within the context of different disciplinary and sub-disciplinary cultures and varying data practices is an important aspect of the context that needs to be understood. (para. 5)

Stanton et al. (2011) placed students in master’s level library and information science (LIS) programs on e-science projects and asked them to keep a log of their activities. The log analysis, which sought out mentions of technology skills and subject expertise, found that e-science professionals needed to work with data (metadata standards, data integrity, and quality assurance), people (communication skills, project management skills, and ability to collaborate), and things (web content management systems, grid computing, and scripting and programming). They undertook their analysis with the intent of developing a graduate-level curriculum to be included in LIS programs; however, they concluded that most e-science positions are not asking for such a diverse range of skills to be present in one person, and, due to the large number of courses that would be needed, that it is unlikely that students could take the suggested number of courses in a two-year program. Rather, the authors suggest that students choose a range of electives depending on their interests and locate internships to gain on-the-job experience.

Taking the employers’ side of the issue, Alvar, Brooks, Ham, Poegel, and Rosencrans (2011) examined a series of librarian job advertisements that they categorized as e-science related. Similar to previous studies, they found that communication and collaboration were the

most sought after personal abilities, along with subject knowledge and technical expertise in working with and managing data.

With LIS programs unable to provide all the training needed to become an e-science professional, it falls on the employing library and individual librarian to have applicable post-graduate training. Creamer, Morales, Crespo, Kafel, and Martin (2012) surveyed health science and science and technology librarians to determine the areas in which they thought there was a need for additional training to meet the requirements of researchers who request data management services. Participants indicated a need to learn about conducting data interviews, assisting with creating data management plans, and gaining hands-on experience in curating and describing large datasets. As a result of their survey, they have developed an online portal<sup>2</sup> to help librarians learn more about educational opportunities related to e-science librarianship.

### **International Activities**

Supporting e-science is an institutional, regional, national, and global concern (Lippincott, 2010). For example the Research Councils in the United Kingdom (RCUK) began planning for e-science in 2001 by investing in a national research infrastructure with centers that focus on the preservation and curation of research data and the development of collaboration tools to be used by virtual research communities. This effort continued in 2006 with representatives from the Joint Information Systems Committee (JISC), the Research Information Network (RIN), and the British Library, and culminated with the release of a report, *20/20*

*Vision: An e-infrastructure for the next decade* (Bicarregui et al., 2006). Library representatives

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<sup>2</sup> The E-Science Portal for New England Librarians (<http://esciencelibrary.umassmed.edu/>) is “designed for librarians working in research organizations that generate, share, store and/or use data for basic scientific research in the health, biological, and physical sciences. Bringing together resources on education, outreach and collaboration, current practices and e-science news—the portal provides librarians with the tools, knowledge and skills to effectively participate in networked science” (University of Massachusetts Medical School, 2010).

in this national report acknowledged that libraries have a role in e-science and reinforced the importance of collaboration. The final report advocated for additional training and funding resources to support e-science, and communicated the importance of adopting appropriate metadata standards and developing national and subject-based research repositories, and the need to fund theoretical and applied research to address long-term digital preservation and curation requirements.

The development of the Digital Curation Centre (DCC) in the United Kingdom was based on the JISC/RCUK e-infrastructure initiatives.<sup>3</sup> The DCC, which focuses on research and disseminates information about data curation, has become a center for best practices and expert advice and a clearinghouse for information on metadata standards, data management plans, and repository software. JISC has also funded a number of studies that are shaping the role of

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<sup>3</sup> In addition to establishing the Digital Curation Centre there were eight identified initiatives for 2002-2005:

1. Development through RSLG of a national repository for the preservation of e-journals used by the community. Completion of the JISC e-journal archiving feasibility study commenced in April 2002 to support the scoping and implementation of this service.
2. Completion of a web-archiving feasibility study being jointly funded by JCIE and Wellcome Trust and development of web-archiving initiatives including a pilot Archive for JISC Project websites in 2002-2003.
3. Completion of preservation risk and retention criteria assessments for all JISC funded content, during 2002-3.
4. Future calls in subsequent years to implement their recommendations for services, and integration of preservation activity and standards into repositories funded by JISC.
5. A series of community calls to support records management and digital preservation in institutions. This would focus initially on records management but increasingly focus on digital preservation in subsequent years.
6. Development of the Digital Preservation Coalition as an independent entity with JISC membership and sector activity supported by JISC.
7. JISC Partnership funding. Facility for external organizations to propose joint funding of work of mutual interest in support of this strategy.
8. Continuing development of JISC Digital Preservation Focus activities through the work of the Programme Director and Electronic Records Manager. (Beagrie, 2002)

libraries in data management (Frieman, Ward, Jones, Molloy, & Snow, 2010; Swan & Brown, 2008). Swan and Brown (2008) identify four distinct roles: data creator, data scientist, data manager, and data librarian. Central to these roles is for data librarians to: train researchers to be more data-aware, adopt a data archiving and preservation role, and train new data librarians. Frieman et al. (2010) conducted semi-structured interviews to understand how researchers create, manage, and preserve research data, teaching materials, and administrative records. Their findings suggested a number of important things for librarians to consider when developing new programs and services, such as the need for tools and resources to be simple, engaging, and easy to access. The researchers with whom they spoke were interested in guidance and support for data management, but were often unaware of existing resources and training. Researchers also stated that training opportunities were often inconveniently timed and not well-tailored to their individual needs. Many thought that brief training, online resources, or someone to talk to face-to-face would be more helpful.

A survey conducted by Cox and Pinfield (2013) of university libraries in the United Kingdom identified how the libraries were involved in research data management and the extent to which the development of research data management services was a strategic priority for them. Outside of large research-intensive institutions Cox and Pinfield (2013) found limited services were offered. Reasons given for the lack of more services were not having the adequate skills and resources, as well as the need to institute a culture change across the institution. These findings were also mirrored in the survey of services conducted by Corral, Kennan, and Afzal (2013) in which 140 libraries in Australia, New Zealand, Ireland, and the United Kingdom were surveyed for current and planned data management services, target audiences, service constraints, and staff training needs. They found that it was important for library staff to



understand the research environment and methods and workflows in order to design and deliver appropriate support services.

Efforts in the United Kingdom to plan for the infrastructure requirements related to e-science and to work with scientists, computer professionals, and librarians to develop national level principles and policies have resulted in a well-coordinated effort to advance e-science and support the research community. Auckland (2012), writing for the RLUK (Research Libraries UK), reports on the skills needed to support researchers and compares different types of library support for researchers.

Libraries in the European Union (EU), Australia, and New Zealand are working in e-science and participating in national policy level discussions (Digital Archiving Consultancy, 2008; Munch, 2011); however, when it comes to implementation at the local level, university research libraries outside the U.S. are experiencing similar barriers to those identified by ARL affiliated libraries (Hey & Hey, 2006; Kallenborn & Becker, 2008). After analyzing the role of library and information-based services in a number of German-sponsored e-science projects in 2005-2006, Osswald (2008) discovered that only three of nine e-science projects involved libraries. An analysis of sponsored research in the United Kingdom showed only two of 51 funded projects for that period were concerned with data management and data access (Osswald, 2008). Although EU libraries are experiencing difficulties in gaining formal recognition as partners, many of them are creating the foundation for future partnerships and building digital data repositories (Gastinger, 2009).

### **Theoretical Framework**

The ARL Task Force on E-Science suggests that research libraries “engage the broader community in a fundamental reassessment of the research library’s role and structure, in effect,

in redefining the research library for a new era” (Joint Task Force on Library Support for E-Science, 2007, p. 5). The idea of remaking or transforming an organization is a common theme in the change management literature (Huber & Glick, 1993; Levy & Merry, 1986; Waters, Marzano, & McNulty, 2003; Watzlawick, Weakland, & Fisch, 1974). To categorize the change experience of the libraries in this study, the characteristics of first-order change and second-order change, as defined by Levy and Merry (1986), are used (see Table 2.2). First-order change occurs naturally as organizations grow and develop, and support continuity and order (Bate, 1994); it is often consistent with current values and norms, is readily accepted, and can be incorporated into daily activities using people’s existing knowledge and skills. Such change consists of minor improvements and adjustments in systems, processes, or structures, but does not involve a fundamental change in strategy, core values, or identity (Levy & Merry, 1986).

Second-order change involves not only developing the organization, but also transforming the core of the organization. It is “multidimensional, multi-level, qualitative, discontinuous, radical organizational change involving a paradigmatic shift” (Levy & Merry, 1986, p. 5). Second-order change challenges or conflicts with prevailing values and norms, and is a break from the previous way of thinking and doing.

Levy and Merry (1986) developed their list of characteristics based on a survey of the literature from the fields of management, organization, and change theory. First-order and second-order changes have been the topic of numerous studies (Allen, 2009; Bess, 2006; Graf, 2010; Lanier, 2009; Sanders, 2009; Wilbur, 2005). Titus (1998) and Hanson (1995) have specifically applied Levy and Merry’s work in the university setting. Those libraries that have been successful in participating in e-science initiatives, they found, had a greater understanding

of the nature of change occurring and could better inform other libraries which are considering becoming involved in e-science.

Table 2.2

*Characteristics of First-Order Change and Second-Order Change*

First-Order Change	Second-Order Change
A change in one or a few dimensions, components, or aspects	Multidimensional, multicomponent, and multiaspectual
A change in one or a few levels (individual and group levels)	Multilevel change (individuals, groups, the whole organization)
Change in one or two behavioral aspects (attitudes, values)	Changes in all behavioral aspects (attitude, norms, values, perceptions, beliefs, world view, behaviors)
A quantitative change	A qualitative change
A change in content	A change in context
Continuity, improvements, and development in the same direction	Discontinuity, taking a new direction
Incremental changes	Revolutionary jumps
Logical and rational	Seeming irrational, based on different logic
Does not change the world view, the paradigm	Results in a new world view, new paradigm
Within the old state of being (thinking and acting)	Results in a new state of being (thinking and acting)

Source: *Organizational Transformation: Approaches, Strategies, Theories* by Amir Levy and Uri Merry. Copyright ©1986 by Preager Publishers. Reproduced with permission of ABC-CLIO, Santa Barbara, CA.

### Research Questions

Study questions relate to the role of the university research library in departmental and campus wide e-science initiatives, the resulting internal changes, and the leadership issues which bring about those changes. Library activities are placed in the context of the larger institutions' e-science activities and in conjunction with key strategic partners. The investigator addressed the study questions listed in Table 2.3.

Table 2.3

*Research Questions*

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**Institutional Level <sup>4</sup>**

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1. How does the institution define e-science?
  2. Which disciplines or fields are included in e-science?
  3. To what extent do the institutions view e-science as part of e-research?
  4. How do the institutions define e-research?
  5. Does that definition apply to the social sciences and humanities?
  6. What e-science programs and services have been developed?
    - a. How long have the programs and services been operational?
    - b. What changes have occurred in these programs and services?
  7. Why did the institution become involved in e-science?
  8. How does e-science align with the institution's mission?
  9. How does e-science fit within the institution's vision?
  10. What institutional factors do administrators identify as critical (very important to achieving desired goals) to implementing e-science?
  11. Which internal and external strategic partners are critical (very important to achieving desired goals) to implementing e-science?
    - a. What resources did these partners bring to the relationship?
    - b. Are the partners still involved in e-science?
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**Strategic Partner Level <sup>5</sup>**

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12. What were the major events leading to the partners' involvement?
13. Who or what was the driving force behind the partners' involvement?
14. What role did the strategic partners play in e-science programming and services?
15. What resources (skills, staff, and new systems) were needed to implement e-science programs?
  - a. What resources did the partners contribute to e-science programs?
  - b. Were those resources secured through grant funds?
  - c. What resources did the institution contribute?
  - d. What resources did the library contribute?
16. What is the relationship between the strategic partner and the library?
17. How long have the partners been working with the library?
18. How was the relationship between the strategic partner and the library established?
19. How has the relationship evolved?
20. How has the relationship been helpful in implementing e-science programs?

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<sup>4</sup> This set of questions focuses on academic programs.

<sup>5</sup> A strategic partner is one that can provide physical and/or intellectual resources towards the achievement of a defined common goal. This could be an individual, department, center, or institute.

Table 2.3 (*continued*)

*Research Questions*

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**Library Level**

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21. Why did the library become involved in e-science?
    - a. What are the library's rationales for supporting e-science?
    - b. Was there external need for the library to become involved?
    - c. Does the library have a vision for e-science?
    - d. How does e-science align with the library's mission?
    - e. How do e-science programs align with existing strategic library goals?
  22. When did the library become involved in e-science?
    - a. Who or what was the driving force behind the initiative?
    - b. What were the major events leading to the library's involvement in e-science?
  23. What e-science programs and services are offered?
    - a. For which disciplines or fields are the programs and services being offered?
    - b. How far along in the library in the implementation of e-science programs and services?
    - c. Which programs and services were established early?
    - d. How have these programs and services evolved?
    - e. How does the library deliver these programs and services?
    - f. Are some programs and services more critical than others?
  24. What library resources were needed to implement e-science?
    - a. What are the skill sets librarians need to support e-science?
    - b. Are librarians learning new skills in order to support e-science?
    - c. What collections are needed to support e-science?
    - d. What technologies are needed to support e-science?
    - e. What facilities are needed to support e-science?
  25. Has the library's participation in e-science initiatives resulted in incremental (small and methodical) or revolutionary (major and transformational) changes (to systems, processes, and the organizational structure)?
  26. What was the role of library administrators in implementing changes related to e-science?
    - a. Who provides the leadership (institution, strategic partners, and/or the library)?
    - b. Who set the vision to direct the change effort?
    - c. Is it a shared vision?
    - d. How were staff empowered to act?
    - e. How was the need to change communicated?
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## **Procedures**

Qualitative research, which is often multimethod, explores phenomena in a natural setting, and interprets those phenomena in terms of the meanings people experience (Denzin & Lincoln, 2005). One form of qualitative research is the case study, which is “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context when the boundaries between phenomenon and context are not clearly evident” (Yin, 2009, p. 18). This study meets the criteria identified by Yin (2009) in that it:

- studies a modern management problem;
- uses a variety of data collection methods;
- asks how something worked; and
- seeks varied and complementary perspectives to address the research questions.

A multiple case design allows for the examination of processes and results across many cases, the identification of how individual cases might be affected by different environments, and the specific conditions under which findings occur. It may also help to form more general categories of how the specific conditions might be related. This makes the results more compelling than those from a single case and demonstrates the issues across a more varied range of circumstances than a single case can provide. Generalizability could be enhanced relative to a single case. Multiple-case designs are therefore more powerful than single-case designs in this respect, and more extensive descriptions and explanations of the issues are developed (Chmiliar, 2009).

## **Site Selection**

ARL, which is comprised of 126 research-intensive institutions in the United States and Canada (as of October 2010), has been studying the role of libraries in e-science since 2007. To

narrow the focus of this study, the investigator eliminated non-university research public libraries and government libraries in the United States and all Canadian libraries from the ARL membership list, which reduced the population to 99 libraries. The investigator chose to focus on U.S. libraries because these institutions are among the largest university recipients of federal funds.

The investigator searched the library and institutional websites of the 99 members to locate strategic planning documents, stated initiatives, institutional priorities, frameworks, directions, annual reports, and mission and vision statements to determine if there were any references to e-science. In addition, she reviewed the library's website, the university's main website, and portions of the website dedicated to research departments, institutes, and centers. If no relevant documents were available, or if the materials found were more than five years old, the investigator sent an e-mail message to the online reference service at the library to determine if such documents existed.

Nineteen libraries did not have strategic planning documents because they were either currently engaged in the strategic planning process, had recently hired a new director, moved away from formalized planning programs, or did not have any e-science activities documented at the university level, reducing the population to 80. The collected documents were searched for indicators of e-science, e-research, or cyber-research initiatives; Table 2.4 contains a list of the relevant terms used in this search process.

Table 2.4

*Relevant Terms*

Relevant Terms	
big science	e-science
collaboration	e-social sciences
collaborative science	embedded librarians
computational science	information discovery
computational technologies	high performance computing
curation	integrative science
cyberinfrastructure	informatics
cyberscholarship	infrastructure
data	inter-disciplinary
data centers	metadata
data collection	new partnerships
data curation	new roles
data intensive	Office of Research
data management	partnerships
data mining	raw data
data preservation	research
data sharing	research community
data sharing plans	research methods
data-driven research	scientific data
data-intensive research	small science
datasets	storage
discovery tools	strategic partnerships
distributive science	team science
e-humanities	trans-disciplinary
e-research	transformation
	transformative



The search produced 31 ARL libraries that had e-science initiatives at the library level and formal support among institutional administrators. After a second review of strategic planning documents, these 31 libraries were divided into three categories based on the Stage-Gate<sup>®6</sup> process (Cooper, 2001):

1. general discussion and data gathering: libraries that were just beginning to think about planning e-science services;
2. planning, designing, and marketing: libraries that had made a commitment to designing an e-science program but had not yet fully implemented programming; and
3. established programs and services: libraries that had already redesigned library services, cultivated strategic partnerships, and were actively providing services.

Table 2.5 lists the specific criteria used to place member libraries into one of these three categories. Of the 31 libraries, 7 were categorized as general, 14 as planning, and 10 as established. Libraries in the general discussion and planning phases were eliminated from the list of potential sites because they were not far enough along in the implementation process to add meaningful content to the study. Duane Webster, Executive Director Emeritus of ARL, and Neil Rambo, ARL Visiting Program Officer for Research and E-Science from 2007-2009, were contacted and asked to review both the criteria used and the categorization of the 10 libraries. They agreed that the criteria used were relevant and complete and that the libraries were properly categorized.

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<sup>6</sup> The Stage-Gate<sup>®</sup> process has five steps: (1) assessing the environment, (2) building a business case, (3) product development, (4) testing and validation, and (5) launch (Stage-Gate International, n.d.).

Table 2.5

*Criteria Used to Place Libraries*

<b>Category</b>	<b>Description</b>
<b>Established programs and services</b>	Staff formally assigned to the activity Budget allocated to the activity to maintain and sustain Established partnerships Routine administration/oversight infrastructure in place Policies in place regarding use of services Ongoing evaluation and data collection Use of programs and services Visibility of programs and services (both in marketing and in organizational structure) Campus acknowledgement of activity as necessary
<b>Program is being planned, designed, and marketed</b>	Committed start-up infrastructure in place Desired outcomes identified Promotional strategies developed and implemented with target audiences Job descriptions written or re-written Strategic partnerships identified
<b>General discussion and data gathering begun</b>	Start-up project team in place and roles assigned Assessment of need (environmental scan) completed? Educational activities for staff and patrons, research regarding existing implementations and implementation options Target users identified Opinion leaders outside library active in discussions Discussion to implement (or not) is made collectively by all system stakeholders

The investigator further narrowed down the 10 libraries with established programs to 6, which represented public, private, and land-grant institutions, as well as institutions that had a national reputation in the areas of scientific research and innovative programming. Then, the investigator compiled supplemental data for the six sites, such as geographic location, total research dollars, library budget, and number of library staff. The supplemental information,

along with the strategic planning documents and information from the websites of the six institutions and libraries, was reviewed to complete a brief description of e-science activities. There was much overlap in two of the six possible participants. As result, the number of institutions to be invited to participate in the study was reduced from six to four.

## **Recruitment**

The chair of the researcher's dissertation committee sent an e-mail message to the library directors<sup>7</sup> outlining the research study, the importance of their participation in the study, and notification that a formal letter requesting their inclusion would be sent via U.S. Postal Service (see Appendix A). Once the chair received some indication that the director was willing to participate in the study, the investigator sent a letter on institutional letterhead. The letter included an introduction, an overview of the research project, and a request for a telephone call to discuss inclusion in the research study (see Appendix B).

During a subsequent phone conversation with the library director (or his/her designee), the investigator confirmed that the library had been placed in the correct category. Once the placement was confirmed, the investigator conveyed to the director the importance of the library's participation in the research project, and reviewed the information on the library's e-science activities that had been collected from the institution and library websites. The conversation included potential library personnel and external partners to be interviewed. The investigator also reviewed the purpose of the focus group interviews, and requested a list of names of potential staff to participate.

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<sup>7</sup> "Director" will be used as the common title throughout this dissertation in place of individual titles such as dean of libraries or university librarian to help disguise identities.

## Methodology

For this study, the investigator employed a multimethod approach to data collection. This included developing institutional histories of the institutions' involvement in e-science, gathering and analyzing relevant documentation, and conducting semi-structured interviews (narrative inquiry), and focus group interviews. The institutional history established the context in which e-science activities were occurring. Relevant documents offered additional information on the context in which the institution and the library were operating. Using semi-structured interviews, the investigator asked people to recall a sequence of major events associated with e-science and how e-science had been implemented in the library. Focus group interviews afforded an opportunity for those in the library providing e-science services to reflect on their experiences and the changes that have occurred in the library. Table 2.6 links the various methods and instruments used throughout the study to the study's research questions.

Table 2.6

### *Research Questions with Corresponding Methods of Investigation*

<b>Institutional Level</b>	<b>Method</b>	<b>Instrument Used</b>
1. How does the institution define e-science?	Documents Semi-structured interview	Institution: Q1, Q1a
2. Which disciplines or fields are included in e-science?	Documents Semi-structured interview	Institution: Q1b
3. To what extent do the institutions view e-science as part of e-research?	Documents	Institution: Q2
4. How do the institutions define e-research?	Documents	Institution: Q2
5. Does that definition apply to the social sciences and humanities	Documents	Institution: Q2

Table 2.6 (*continued*)*Research Questions with Corresponding Methods of Investigation*

<b>Institutional Level</b>	<b>Method</b>	<b>Instrument Used</b>
6. What e-science programs and services have been developed? a. How long have the programs and services been operational? b. What changes have occurred in these programs and services?	Documents  Semi-structured interview	Institution: Q3
7. Why did the institution become involved in e-science?	Documents  Semi-structured interview	Institution: Q2a
8. How does e-science align with the institution's mission?	ESI documents <sup>8</sup>  Semi-structured interview	Institution: Q2b
9. How does e-science fit within the institution's vision?	ARL e-science documents	
10. What institutional factors do administrators identify as critical (very important to achieving desired goals) to implementing e-science?	Documents  Semi-structured interview	Institution: Q4
11. Which strategic partners, internal or external to the university, are critical (very important to achieving desired goals) to implementing e-science? a. What resources did these partners bring to the relationship? b. Are the partners still involved in e-science?	Documents  Narrative inquiry  Semi-structured interview	Institution: Q5, Q5a, Q5b, Q5c, Q6, Q7
<b>Strategic Partner Level</b>	<b>Method</b>	<b>Instrument Used</b>
12. What were the major events leading to the partners' involvement?	Semi-structured interview  Narrative inquiry	Partner: Q1, Q2
13. Who or what was the driving force behind the partners' involvement?	Narrative inquiry	Partner: Q1

<sup>8</sup> Some sites selected for inclusion for this study are currently participating in the Association of Research Libraries/Digital Library Federation (ARL/DLF)/DuraSpace E-Science Institute (ESI). The ESI is an opportunity to help research libraries develop strategies for engaging with e-science and digital research on their campuses and collaboratively. Participants in this institute are asked to perform an environmental scan of e-science at their institution.

Table 2.6 (*continued*)*Research Questions with Corresponding Methods of Investigation*

<b>Strategic Partner Level</b>	<b>Method</b>	<b>Instrument Used</b>
14. What role did the strategic partners play in e-science programming and services?	Documents Semi-structured interview	Partner: Q3, Q3a, Q3b
15. What resources (skills, staff, and new systems) were needed to implement e-science programs? a. What resources did the partners contribute to e-science programs? b. Were those resources secured through grant funds? c. What resources did the institution contribute? d. What resources did the library contribute?	Documents Semi-structured interview	Partner: Q4, Q4a, Q4b, Q4c
16. What is the relationship between the strategic partner and the library?	Semi-structured interview	Partner: Q5
17. How long have the partners been working with the library?	Semi-structured interview	Partner: Q6a
18. How was the relationship between the strategic partner and the library established?	Semi-structured interview	Partner: Q6a
19. Has the relationship evolved?	Semi-structured interview	Partner: Q6c, Q6d
20. How has the relationship been helpful in implementing e-science programs?	Semi-structured interview	Partner: Q8b
<b>Library Level</b>	<b>Method</b>	<b>Instrument Used</b>
21. Why did the libraries become involved in e-science? a. What are the libraries' rationales for supporting e-science? b. Was there external need for the libraries to become involved? c. Does the library have a vision for e-science? d. How does e-science align with the library's mission? e. How do e-science programs align with existing strategic library goals?	Documents Semi-structured interview	Library: Q4, Q7

Table 2.6 (*continued*)*Research Questions with Corresponding Methods of Investigation*

<b>Library Level</b>	<b>Method</b>	<b>Instrument Used</b>
22. When did the libraries become involved in e-science? a. Who or what was the driving force behind the initiative? b. What were the major events leading to the libraries' involvement in e-science?	Documents Narrative Inquiry	Library: Q1, Q5, Q6
23. What e-science programs and services are offered? a. For which disciplines or fields are the programs and services being offered? b. How far along are libraries in the implementation of e-science programs and services? c. Which programs and services were established early? d. How have these programs and services evolved? e. How does the library deliver these programs and services? f. Are some programs and services more critical than others?	Documents Semi-structured interview Check list (Table 1)	Library: Q8, Q8a, Q8b, Q9, Q9a, Q9b, Q9c
24. What library resources were needed to implement e-science? a. What are the skill sets librarians need to support e-science? b. Are librarians learning new skills in order to support e-science? c. What collections are needed to support e-science? d. What technology is needed to support e-science? e. What facilities are needed to support e-science?	Documents Semi-structured interview	Library: Q10, Q10a, Q10b, Q10c, Q10d, Q10e, Q10f

Table 2.6 (*continued*)*Research Questions with Corresponding Methods of Investigation*

<b>Library Level</b>	<b>Method</b>	<b>Instrument Used</b>
25. Has the libraries' participation in e-science initiatives resulted in incremental (small and methodical) or revolutionary (major and transformational) changes (to systems, processes, and the organizational structure)?	Documents Semi-structured interview Focus group	Library: Q11, Q11a, Q11b, Q11c  Focus Group: Q1, Q1a Q2, Q3, Q4
26. What was the role of library administrators in implementing changes related to e-science? a. Who provides the leadership (institution, strategic partners, and/or the library)? b. Who set the vision to direct the change effort? c. Is it a shared vision? d. How were staff empowered to act? e. How was the need for change communicated?	Semi-structured interview	Library: Q12, Q12a, Q12b, Q12c, Q12d, Q12e, Q12f, Q12g, Q12h, Q12h, Q12i

**Document Analysis**

Document types of various kinds were collected to provide a brief history of how the institutions, strategic partners, and the libraries became involved in e-science. The result is an extensive picture of e-science at each institution, specifically regarding the role of the library. The researcher searched the website of each institution for publicly-available documents related to e-science activities and requested that the individuals participating in the study provide any additional documentation. Document types included, but were not limited to, strategic planning documents, annual reports, speeches, team or committee reports, job advertisements, newspaper clippings, journal articles, and professional presentations. All documents were reviewed and



those that were relevant were further examined using thematic analysis; thematic analysis is the analysis of text (or other symbolic materials) for the presence of certain themes, trends, and concepts.

### **Institutional History**

An institutional history is a narrative that records key points about institutional processes and events over time that (in this case) led to the emergence and advancement of e-science. The purpose is to introduce institutional factors (see the section on research questions) into the narrative regarding the status of e-science at each institution (Prasad, Hall, & Thummuru, 2006). An institutional history of e-science activities was developed for each site based on document analysis and was supplemented with information obtained in the interviews.

### **Narrative Inquiry**

Stories are communicated from generation to generation as a method of teaching values as well as lessons about life. These stories often follow a pattern of birth, death, rebirth; separations, initiation, return; or simply, beginning, middle, resolution. The basic pattern of conflict followed by resolution, or crisis followed by victory, is a way that stories provide the audience with a sense of shared past and common cause (Atkinson, 1998).

Narrative inquiry involves the use of stories to identify key events. The researcher works with participants to probe one or more of the major events in order to document the interviewees' stories about their experience, and to understand the context in which the stories are remembered and communicated. "The purpose is to see how respondents in interviews impose order on the flow of experiences to make sense of events and actions" (Riessman, 1993, p. 2). The researcher is then able to reconstruct a holistic picture of the environment in all its complexity and richness (Webster & Mertova, 2007) in which key events and individuals are identified. In this study, key

events are described as setting strategic goals, reaching important milestones, reorganizing the institution, and assigning resources to e-science. Narratives, as described by Ospina and Dodge (2005), have five essential characteristics:

1. They serve as an account of characters and selected events that occur over time, with a beginning, middle, and end.
2. They are retrospective interpretations of sequential events from a certain point of view.
3. They focus on human intention and action.
4. They are part of the process of constructing identity (self in relation to others).
5. They are coauthored by the narrator and the audience. (p. 145)

Narrative inquiry has been applied in a number of relevant subject areas, such as information technology (Cater-Steel, Hine, & Grant, 2010), higher education (Clandinin & Connelly, 1996; De Long, 2012; MacCarrick, 2009; Spiller, 2010), change management (Garcia-Lorenzo, 2010), and organizational studies (Boje, 1991; Czarniawska, 2007). Narrative inquiry is useful in organizing and finding meaning in past events; in organizations it can be used to identify which actions contributed positively or negatively to attaining set goals (Polkinghorne, 1988, 1995).

Narrative inquiry was used with the representatives from university administration, strategic partners, library directors, and associate directors to build on the information discovered during document analysis; major events were used to engage the participants as they shared their stories and perspectives of how the universities became involved in e-science and how the role of the libraries evolved (see Tables 2.7 and 2.8).

Table 2.7

*Institutional Level Semi-Structured Interview Questions with a Narrative Inquiry Component*

Questions	Sub-questions
1. Verify information obtained from university documents	a. Definition of e-science b. List of disciplines or fields considered to be part of e-science
2. Is the university involved in e-research, a broader term than e-science? <i>Probe</i>	a. Was it important for the university to become involved in e-science and why? b. <i>Provide a copy of the institution's mission statement.</i> How does e-science fit with the institution's mission? Can you elaborate with a specific example?
3. How have e-science programs and services at the university changed since their inception?	
4. What institutional factors (infrastructure, funding, and administrative support) do you think have been critical in implementing e-science?	a. How have they been critical?
5. Who are the internal and external partners critical (very important to achieving desired goals) to implementing e-science?	a. What was their role? b. What resources did they provide? c. Are they still involved?
6. What role does the library play in e-science?	
7. Do you see that role changing over time?	

Table 2.8

*Strategic Partner Semi-Structured Interview Questions with a Narrative Inquiry Component*

Questions	Sub-questions
1. What were the influences behind your decision to become involved?	
2. Among the influences, was one very critical? <i>Probe</i>	
3. With which e-science programs and services have you been associated?	a. Discuss those programs and services. b. Has your involvement changed over time?
4. Thinking back, what resources (skills, staff, and new systems) were needed to implement e-science programs?	b. What resources did you contribute? c. How are those resources obtained? Grants? d. To what extent has the institution/library supported you in your e-science efforts?
5. How would you describe your relationship with the library in regard to e-science (resource, partner, and/or peer)?	
6. Regarding the university library,	a. When (and why) did you start working with it on e-science projects? b. How has the library supported your e-science efforts? c. Has your relationship with the library evolved over time? If so how? d. How might you characterize that relationship over the next 5 years?

**Semi-Structured Interviews**

The library director and the associate or assistant director responsible for overseeing e-science activities were interviewed. These interviews provided different viewpoints of library e-

science activities, the development of the programs and services, and the changes that have taken place. They also indicated how the libraries responded, both internally and externally, to the need to support e-science on campus.

The interviews built on the information identified in the document analysis (see Table 2.9). The interview questions were brief and succinct; they addressed one issue at a time by focusing on e-science, determining how and why participants became involved, identifying their roles, and highlighting any memorable events that were part of the implementation process. Each interview included an introduction, detailed questions, and a wrap up (Courage & Baxter, 2005).

Table 2.9

*Semi-Structured Interview Questions with a Narrative Inquiry Component*

Questions	Sub-questions
1. When did the library first become involved in e-science?	
2. Were you the director at the time?	
3. Is the library engaged in more than e-science (e-research per se?). This interview and study, however, will only focus on the e-science aspect.	
4. Why is it important for the library to be involved in campus e-science programs? <i>Probe for rationale/vision.</i>	
5. What were the influences behind the decision to become involved in e-science? <ul style="list-style-type: none"> <li>• Driving forces</li> <li>• Major events</li> </ul>	
6. How does e-science align with the library's mission and strategic goals? <i>(copy will be provided)</i>	
7. What were the key milestones in getting <i>(select one major event from documents and insert here)</i> started?	

Table 2.9 (continued)

*Semi-Structured Interview Questions with a Narrative Inquiry Component*

Questions	Sub-questions
8. How far along in the implementation of e-science programs and services is the library?	<ul style="list-style-type: none"> <li>a. Which programs and services were established first and why?</li> <li>b. Have these programs and services changed over time?</li> <li>c. Are additional programs and services being planned?</li> </ul>
9. What part of the library infrastructure (staff, collections, technology, and facilities) were needed to implement e-science programs?	<ul style="list-style-type: none"> <li>a. What skills do your staff need? <ul style="list-style-type: none"> <li>i. Are they learning new skills?</li> </ul> </li> <li>b. Were new staff hired or transferred?</li> <li>c. Have new collections been acquired to accommodate e-science work?</li> <li>d. What new technologies has the library acquired and supported in order to accommodate e-science work?</li> <li>e. Have the library facilities been modified in any way to support e-science work?</li> <li>f. Have these needs changed over time?</li> </ul>
10. Has the library undergone any structural changes to accommodate e-science?	<ul style="list-style-type: none"> <li>a. What are they?</li> <li>b. Would you categorize these changes as incremental (small and methodical) or revolutionary (major and sudden)?</li> <li>c. Do you expect any future changes?</li> </ul>

Table 2.9 (continued)

*Semi-Structured Interview Questions with a Narrative Inquiry Component*

Questions	Sub-questions
11. Turning to the matter of leadership in bringing about the changes associated with e-science	<ul style="list-style-type: none"> <li>a. How do you define leadership?</li> <li>b. Is leadership coming from outside the library (external)?</li> <li>c. What leadership role are you assuming to bring about the change?</li> <li>d. What are the leadership challenges you face?</li> <li>e. Were you alone in setting the vision to direct the change?</li> <li>f. How was the need to change communicated?</li> <li>g. How were staff empowered to change?</li> <li>h. How is the change effort sustained?</li> <li>i. Have there been any major hurdles in bringing about the desired changes?</li> </ul>

### Focus Group Interviews

To gain the perspective of those developing and offering e-science programs and services, a focus group interview was conducted at each institution with library staff members. The investigator used this approach because such interviews enable in-depth examination of a topic as the participants discuss their experiences and the interviewer gains a rich understanding of the issues from their perspectives. The emphasis was on the changes that occurred in the library because of the library's involvement in supporting e-science and on who is leading these changes; Table 2.10 lists the pertinent questions.

Table 2.10

*Librarian Focus Group Questions*

Questions	Sub-questions
1. Have there been any changes in the library's organizational structure (reporting, management) so that the library can develop and offer e-science programs and services? If so, elaborate.	
2. Have there been any changes in the library's organizational structure (reporting, management) so that the library can develop and offer e-science programs and services? If so, elaborate.	a. Can you estimate the number of people affected by this change?
3. Have there been any changes in library processes (how staff are hired, evaluated, trained, contacts made, programs developed, skill set needed) related to e-science?	
4. Thinking of how your job has changed in the past 6 years.... would you say you are doing the same type of work and only the <b>content</b> (type of materials, skills used) has changed, or has the <b>context</b> (environment, new skills needed) in which you are working changed? Please elaborate.	
5. Would you characterize the changes we have talked about today as incremental (small and methodical) or revolutionary (major and transformational)? Please elaborate.	

The library director or designee issued the invitation to potential focus group participants, requesting their participation in the interview. The investigator explained the purpose of the study and supplied potential participants with relevant information before the focus group interview was conducted to assist them in deciding whether to participate.



The investigator served as moderator, probed for responses, and encouraged everyone in attendance to participate. With the permission of all study participants, she used a digital recorder to capture the sessions and hired a professional transcription service to transcribe the recordings (see next section).

## **Data Collection**

Data collection, which occurred in fall 2011 and winter 2012, focused on the five-year period from January 2005 to December 2010. The emergence of e-science may have begun at the case study sites before 2005, but a national dialog began among the scientific community in 2005 with the publication of *Long-lived digital data collections: Enabling research and education in the 21<sup>st</sup> century* (National Science Board, 2005). This work brought the importance of preserving datasets to the forefront. In 2006, ARL formed a Joint Task Force on Library Support for E-Science to explore the role of libraries in e-science, stating that it was time to get involved. Since many strategic plans look three to five years out, participating libraries that have set goals related to e-science would have had time to plan and launch initiatives within the five years covered by the study. Activities prior to 2005 are included in the institutional history as appropriate. In some cases, the persons selected to participate in the study have not been working at the institution for the entire five-year period covered by the study. In this situation, participants were asked to discuss their experiences since they arrived at the institution.

When it was not possible to schedule a face-to-face meeting with the library director or associate director while the investigator was visiting the campus, the interview was conducted over the telephone. Everyone who was interviewed was asked to sign a consent form stating his or her agreement to participate and allowing the interview session to be recorded with a digital recorder (see Appendix C). These recordings were transcribed by a professional transcription

service. The transcripts were sent to participants to review before the analysis. The finalized versions were used for thematic analysis and were the basis for the case reports.

## Data Analysis

Thematic analysis was used to process data transcribed from the interviews as well as from the collection of relevant documents. A codebook was developed after carefully reading the documents and transcripts to define codes for themes and subthemes (see Table 2.11 for an excerpt from the codebook). Then, all documents were re-read, marking and coding text instances of themes and subthemes with theme codes. After all transcript coding was completed, text segments that were similarly coded for each library were grouped together for further analysis in a spreadsheet. Once the coded-text instances were clustered within the library for each theme code, code validation was conducted. All text instances for each theme code were read to ensure they had been properly coded into that particular theme category. If they had been coded incorrectly, they were recoded and regrouped with the correct theme code (Klenke, 2008).

Table 2.11

*Excerpt From Codebook*

	Level		Theme
1	2	3	
26			<b>Role of Administration</b>
	.01		Who provides the leadership
	.02		Leadership challenges
		.0201	Educating faculty
		.0202	Identifying library role
		.0203	Helping those who can't help themselves
		.0204	Amount of data
		.0205	Staff expertise
		.0206	Building awareness
		.0207	Identifying institutional roles
		.0208	Competing priorities

Hierarchical analysis was then conducted using the codes in the codebook to determine whether any of the theme-code groupings could be grouped to help define a higher-level concept that encompassed multiple theme groups. Hierarchical analysis of theme codes continued from the bottom up until the key major theme groupings of significance were identified. The theme hierarchy is represented in a tree structure with the most significant themes at the top. The researcher then reviewed each major theme code for each library and compared theme instances across cases with Levy's and Merry's (1986) characteristics of first- order change and second-order change (see Table 2.2), and with the services identified in Table 2.1.

### **Data Quality**

It is typical for two people experiencing the same event to describe what happened differently. The story to be re-told depends on the values and interests of the narrator: "A personal narrative is not meant to be read as an exact record of what happened nor is it a mirror of a world 'out there'" (Riessman, 1993, p. 64). Webster and Mertova (2007) have observed that there is "consensus in the literature on narrative research that it [narrative research] should not be judged by the same criteria as those that are applied to more traditionally and broadly accepted qualitative and quantitative research methods" (p. 89). However, there are still methods to test the dependability of the data (reliability), as well as the strength of data analysis, trustworthiness of the data, and ease of access to data (validity). As suggested by Yin (2009), the investigator created a case study protocol, a case study database, and a chain of evidence by which an independent investigator could "follow the derivation of any evidence from initial research questions to ultimate case study conclusions" (p. 122). In addition, the investigator provided the interviewees with a summary of their sessions and offered them the opportunity to make corrections, add clarification, or supply additional information, if necessary. She also provided

the library director (or designee) with a draft case study report and requested that the person supply any revisions to ensure its accuracy.

### **Validity**

Riessman (1993) offers four tests for validity that were used in this study. The first test is *persuasiveness*; this test asks if the interpretations of the data are reasonable and convincing. This test will require any theoretical claims to be supported with direct evidence from study participants' accounts and alternative interpretations of the data to be considered. The second test is *correspondence*; analytic categories, interpretations, and conclusions are shared with the participants to determine if there is a recognizable and adequate representation of events. This test served as an opportunity for the participants to determine whether confidentiality was preserved. A third test is *coherence*. This test for validity exists at three different levels: global (goal of the narrator is known), local (the effect of the story is known), and themal (repeated themes); the data collected comes together to form a narrative. The fourth and final test of validity, *pragmatic use*, determines whether the study's results are useful to future researchers. This test is future oriented and will not be considered as part of this research process.

### **Inter-coder Reliability**

The investigator recruited two additional researchers with content analysis experience to code a portion of the interview transcripts from each participant and sample of collected documents. The results were compared with each other as well as with those of the investigator. These activities resulted in 96 percent intercoder reliability. Intercoder reliability refers to the extent to which two or more independent coders agree on the coding of the content of interest with an application of the same coding scheme. Ninety-percent agreement or greater is

considered highly reliable (Cho, 2008). In addition, the investigator coded the same content more than once to ensure stability.

### **Pre-Test**

In order to ensure the quality of data collected throughout this study, the investigator conducted a pre-test at a site selected by the investigator and her dissertation committee. Prior to the site visit, the investigator reviewed the research proposal, research questions, and period of the study (January 2005-December 2010) with the director of libraries at the study site. Based on this review, an appointment was scheduled with selected library staff to review the study objectives, research questions, interview scripts, and potential study sites.

The investigator also gathered feedback and comments on the invitation to participate and subsequent follow-up e-mail messages. In addition, the investigator gained valuable information on issues associated with scheduling the required interviews in a two-day period. Most importantly, the pre-test provided the investigator with feedback on the study research questions, and data collection process; suggestions were incorporated before visiting the institutions selected for the study.

### **Nature of Change**

To verify the characterization of first-order and second-order change, two researchers received a randomized list with changes that came from the interviews and from the document analysis. These outside researchers were asked to categorize the changes as first-order change or second-order change. The results were compared with each other as well as with those of the investigator. Results of the parallel content analyses were in agreement for 95 percent of the coding. For the remaining 5 percent, data were compared and differences resolved.

## **Conclusion**

Changes in how research is conducted will have an effect on how the library carries out its mission of supporting research and other information needs of the university. The traditional processes of library acquisition and preservation of scholarly materials were suitable when scholarly outputs were principally in tangible forms and the responsibility for its stewardship was relatively clear (Ogburn, 2010). There are potentially important new roles for librarians in contributing to data management and supporting research as digital data present new challenges because of volume and relative value of data. Librarians recognize the value of maintaining primary documents for the historical record; they are also cognizant of the planning and effort long-term preservation requires (Carlson & Garritano, 2010). As well, librarians are experienced in navigating complex information systems, have an understanding of how system architecture relates to user needs, and are familiar with the importance of incorporating standards to interoperability.

The role of the library is still being defined and must be balanced with practical skill development and strategic perspectives (Luce, 2008); however, it is clear that university research libraries have opportunities to develop new services and forge new partnerships. How four libraries initiate and implement these changes will be explored in Chapter 3.

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## Chapter 3

### OVERVIEW OF THE FOUR CASE STUDIES

A representative of each library director assisted the investigator with the logistical arrangements for the site visits (case sites A, B, C, and D), including scheduling of interview appointments, communicating with library employees to obtain focus group interview volunteers, and arranging for meeting rooms.<sup>1</sup> The investigator visited three sites (A, B, and C) in November 2011, December 2011, and January 2012 respectively, with several follow-up telephone calls when necessary. The interviews for site D were conducted by telephone in February and March 2012.

All of the library directors, assistant library directors, and librarians agreed to be interviewed; however, only in the cases of sites A and C was contact made with an institutional representative from the office of research willing to participate in the study. Only site C provided access to strategic partners (three of them); sites A, B, and D indicated that there were appropriate strategic partners, but they were not available. Consequently institutional and strategic partner data are used when available to supplement and validate the findings from the interviews with library staff as well as the data available from the document review.

Table 3.1 shows some characteristics for the four universities, including differences in key statistics. Each institution is classified by the Carnegie Foundation for the Advancement of Teaching as a comprehensive doctoral institution with very high research activity; all but one has a medical/veterinary school. Two institutions are located in the Midwest, one institution is in the

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<sup>1</sup> Efforts have been made to anonymize the four institutions without compromising the findings.

South, and one institution is located in the Northeast; two of the institutions are public and two are private.

Table 3.1

*Institutional/Library General Characteristics (numbers are approximate)*

<b>Institutions</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Enrollment	44,000	11,000	40,000	21,000
Total library staff	500	225	250	300
Total library expenditures	\$40 million	\$25 million	\$26 million	\$29 million
Total research dollars	\$474 million	\$614 million	\$415 million	\$1.5 billion

### **University A**

The library at University A has been involved in e-science for approximately 10 years. The process by which the library became involved was described as organic and grew out of the library's long history of supporting researchers, engaging in library and information science research, remaining current in e-science issues, and monitoring the relevant literature, as well as providing limited archival services for datasets when requested. The institution's award of a large long-term national grant raised unforeseen policy, data management, and metadata issues as the data transitioned from being stored in boxes on cards and paper, to being captured digitally. Researchers started looking for help with storage, access, and retrieval. As these issues were identified university administration realized that the impact and implications of decisions and systems being put in place went beyond the initial grant; awareness emerged that the university needed to develop a comprehensive solution that could be adapted for use by other researchers. When the library provided advice on metadata and worked with others groups such

as the office of research and information services on campus to address this need, it solidified its involvement on campus.

### **Data Gathering**

The investigator conducted personal interviews with the associate vice chancellor for research, the library director, and the associate library director. She also convened a focus group interview, but with only three librarians who provide e-science services. To expand her understanding of the interview participants' comments, the investigator consulted university and library strategic planning documents, online press releases from the university's administration, scholarly articles written by librarians describing services, and web-based chronicles in the form of news articles and blog posts. The following is a summary of the findings.

### **Institutional Perspective**

At the institutional level, e-science has two main characteristics. First, it is thought of as being highly collaborative and involving many different groups on campus (several of which are administrative), and second, it is based on data that are born digitally and remain in a digital format throughout their life cycle. E-science is a main generator of research data on campus, but areas such as the humanities and social sciences also have significant data needs, and those data formats are different from what is being generated in the life, physical, and engineering sciences; these areas are also supported, fostered, and considered to be part of the larger domain of e-research. E-science support on campus comes from a close working relationship among three

departments: (1) the Office of the Vice Chancellor for Research,<sup>2</sup> (2) the Chief Information Officer,<sup>3</sup> and (3) the library.

The university's mission is based in research, teaching, and service and is built on a foundation of collaboration. In e-science a shift has occurred from individual researchers working independently to the formation of large institutes where people are brought together under research themes. The focus is more multi- and inter-disciplinary than in the past. Overall, there is a greater awareness across campus that information technology has become a ubiquitous, indispensable component of research, information management, and decision making. To strengthen the tradition of innovation and achievement, the university engages a broad array of partners and stakeholders. As a whole, the institution facilitates boundary-crossing interactions among departments and colleges when new knowledge generates new insights.

One barrier to the expansion of e-science campus wide has been cost. It is estimated that it will take at least \$4 million initially to provide the necessary infrastructure to manage efficiently and effectively the data that are currently being produced on campus. This estimate does not include administrative support or staffing. Another barrier is that since this is one of the first institutions to move into this area (planning having begun in the late 1990s), there are no identifiable best practices at the institutional level; decisions are being made as needed, but there is a desire to implement a comprehensive plan rather than react to individual researcher needs. As an example, a campus debate continues to focus on whether data management services should be centralized or decentralized. Moreover, the institution has to deal with researcher resistance to

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<sup>2</sup> The Office of the Vice Chancellor for Research has policymaking and oversight responsibility for the research mission of the institution. The office works collaboratively with the academic colleges and other administrative units to both lead new research initiatives and facilitate the ongoing scholarly endeavors of campus staff, students, and faculty.

<sup>3</sup> The campus Chief Information Officer is responsible for information technology strategies and capabilities supporting excellence in research, education, and outreach. This includes information technology governance, policy, central information technology services, and initiatives to exploit new technologies in support of scholarship.

sharing data. Embracing the new mindset of sharing data presents a new way of thinking for some researchers. As funding agencies place more requirements on researchers to make their data available for others, university administration views this as an opportunity for the campus to discover and institutionalize best practices, to provide the necessary policies and provisions to meet the requirements, and to increase institutional efficiencies.

### **Institutional View of the Library's Role in Supporting E-Science**

The library has taken a lead role in facilitating discussions on policies and services across campus to determine what is needed to foster e-science collaboration. The library is driving the evaluation procedures throughout the planning and implementation phases. The library is also assuming a role in data curation. The university sees the library playing a major role in overseeing whatever centralized service develops: "It is possible that this [service] could be based in the library, supported by IT and research, rather than having it in the research office," said the Associate Vice Chancellor for Research.

### **Library-Based E-Science Services and Programs**

Initially the library was involved in a number of digital humanities projects. Based on that experience, library administration realized that: (1) the library needed a different technology infrastructure to manage the large datasets associated with e-science, and, (2) to assist researchers better with their data management needs, library faculty had to become involved in the research process earlier on (see Table 3.2 for a full list of library e-science services as they relate to each site).

Table 3.2

*Library E-Science Services*

	Sites			
	A	B	C	D
<b>Education</b>				
Continuing education for librarians	X	X	X	
Developing workshops for faculty, students, researchers	X	X	X	X
Supporting data management internships	X		X	
<b>Policy</b>				
Advising on policy and procedures	X	X	X	X
Partnering/managing external data compliance	X		X	X
Setting metadata standards	X			
<b>Research</b>				
Partnering to/securing external funding	X	X	X	X
Writing grants	X	X	X	X
<b>Services</b>				
Applying metadata standards	X	X	X	X
Building institutional repositories (bibliographic and data)	X	X	X	X
Creating permanent URLs	X	X	X	
Creating digital object identifiers for future referencing	X	X	X	X
Data management planning	X	X	X	X
Developing/modifying controlled vocabularies/content standards	X		X	
Dissemination and discovery of datasets	X	X	X	X
Documenting rights management	X	X	X	
Facilitating dataset retrieval	X	X	X	X
Facilitating online journal publishing			X	
Inventorying and creating a registry of local datasets				
Participating as a member of the research team	X		X	X
Promoting the sharing and reuse of data	X	X	X	X
Providing reference and consultation services	X	X	X	X

**Education.** The education efforts related to e-science are twofold. First, the library provides continuing education for librarians to upgrade their skills; anyone wanting to learn more about e-science and data management will not be denied the opportunity. Second, librarians are developing and offering workshops for faculty, students, and researchers focused on the benefits

of managing data, including how to manage data (e.g., file naming, storage, and versioning) on a day-to-day basis; key points for preserving data; options for sharing data; and unique issues related to data citations, intellectual property, and privacy. The goal is to ensure that the data will be secure, discoverable, and preserved for future use. Other educational programs focus on compliance with the National Science Foundation's (NSF) data management requirements,<sup>4</sup> the visualization<sup>5</sup> and presentation of data, management of bibliographic data, and tools for collaboration. Educational programs are offered one-on-one, in small groups, and as self-paced learning through online tutorials and presentations from the library website.

**Policy.** The library has assumed a major role advising on information related policies and establishing university procedures related to e-science and data management. There has been library representation as well as library leadership on university-wide committees dealing with data management issues, such as infrastructure needs and facilitating data compliance options for researchers. The library is also viewed across campus as the location for expertise on applying and setting metadata standards.

**Research.** The library's support of research is twofold. First, the library has been successful in a number of instances in gaining grants to facilitate library-based research related to data management. Second, the library is partnering with faculty to secure external funding to support the library's involvement with research teams as a contributing member.

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<sup>4</sup> Beginning in January 18, 2011, any new proposal submitted to NSF was required to include a supplementary document of no more than two pages labeled "Data Management Plan" (National Science Foundation, n.d.).

<sup>5</sup> A definitional of data visualization is "the graphical presentation of information, with the goal of providing the viewer with a qualitative understanding of the information contents. Information may be data, processes, relations, or concepts. Graphical presentation may entail manipulation of graphical entities (points, lines, shapes, images, text) and attributes (color, size, position, shape). Understanding may involve detection, measurement, and comparison, and is enhanced via interactive techniques and providing the information from multiple views and with multiple techniques" (Ward, 2011, para. 1).



**Services.** The library's most noted service is its institutional repository,<sup>6</sup> which was developed to preserve and provide persistent and reliable access to the digital research and scholarship of faculty, staff, and students in order to give their works the greatest possible recognition and distribution. The repository, used for online journal publishing and to facilitate the dissemination and discovery of locally created datasets, provides permanent uniform resource locators (URLs) and digital object identifiers for future referencing. It also provides a showcase for the library to display its expertise in developing and modifying controlled vocabularies and setting content standards.

The library also provides a number of consultation services, including copyright and rights management, reference services, and data management planning. In addition, librarians participate as members of research teams assisting with data management, and the library actively seeks opportunities to increase those types of partnerships.

**Delivery.** E-science programs and services are delivered through departmental libraries (e.g., engineering, agriculture, and life sciences). However, the library created a new department to provide faculty, researchers, and students with access to experts in digital content creation and analysis and geospatial, textual, and numeric data analysis services. In both instances the emphasis is to partner on writing grant proposals as librarians seek to become embedded throughout the research process.

**Resources needed.** Discussions about the resources needed to provide e-science programs and services begin with having the appropriate staff and skill set. The library has hired new staff with data management skills and has provided professional development opportunities

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<sup>6</sup> A definition of institutional repository is "a university-based institutional repository is a set of services that a university offers to the members of its community for the management and dissemination of digital materials created by the institution and its community members. It is most essentially an organizational commitment to the stewardship of these digital materials, including long-term preservation where appropriate, as well as organization and access or distribution" (Lynch, 2003, p. 2).

for all staff interested in learning more. Beyond knowledge of the tools needed to manage, mine, and analyze data, librarians need to be able to explain the issues and have an understanding of the research process, as well as to be advocates for the library's role in providing expertise in data management. Time management ability is also highly valued because e-science support is viewed as an additional service to be assumed while maintaining the current offerings of library educational and outreach programs and services.

The library purchases commercially available datasets when requested by faculty, researchers, and students, but otherwise does not see the collection development policy as being affected by e-science. On the other hand, the library identified a number of technology-related improvements that needed to be completed in order to provide services, including increased data storage capacity and the purchase of numerous high-end workstations. It also invested heavily in the development of an institutional repository and improved web-discovery tools to assist faculty, students, and researchers with locating library and institutional resources.

Instructional classrooms, collaborative work areas, and meeting spaces have been built within the physical spaces of the main and departmental libraries to facilitate the work and research associated with e-science. An information commons<sup>7</sup> area was created in which library faculty have set hours to work with faculty, researchers, and students to assist with their research and data needs.

**Implementation facilitators and barriers.** A staff shortage was the primary barrier to implementing e-science programs and services. Additionally, some researchers were interested in

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<sup>7</sup> Information commons is used here as a generic term. The characteristics of the information common are identified as offering “shared spaces, real and virtual, where communities with common interests and concerns gather. They take advantage of the networked environment to build information communities, and they benefit from network externalities, meaning the greater the participation, the more valuable the resource. They are interactive, encouraging discourse and exchange among their members. Many are free or low cost. Their participants often contribute new creations after they gain and benefit from access” (Kranich, 2004, p. 30).

using the library solely as a data storage facility. The library was forthcoming in acknowledging when this would be appropriate and when it was not. The library always sought to promote a full suite of educational and data management services.

Facilitators to implementation have been both internal and external. Internally, the staff directly involved in e-science work had made it a priority to develop and offer new services; they have welcomed the challenge of the additional workload. Externally, national initiatives such as the NSF's data management requirements and the open access movement have helped bring the library to the forefront as a center of expertise in the area of data management.

### **Changes Occurring to Provide E-Science Services and Programs**

In 2007, library administration made a conscious effort through strategic planning and reorganization to focus library services on a new future. E-science played a central role in that planning and that future. As explained in the strategic plan,

Over the past several years, the term "E-Science" has been used to describe new research methods in the sciences, social sciences, and humanities that take advantage of increases in computing power, storage capacity, and measurement techniques to ask new questions, as well as new information and communication technologies that link data, people, and computational services together in virtual organizations. E-Science encompasses computationally-intensive inquiry carried out in distributed environments, science that uses large datasets requiring grid computing, as well as inquiry in the social sciences and humanities that requires the management and use of quantitative data or the systematic mining of textual data. Pursuing this proposal will ensure that the University Library will be in a position to

provide ongoing support to established and emergent e-science and e-scholarship programs across campus and with external partners.<sup>8</sup>

Early in the implementation phase of the strategic plan the library director rearranged the departmental structure to form a new department to provide centralized services and programs related to e-science, data management, and scholarly communication. This has resulted in a new oversight structure and workflow changes for the library staff as faculty, researchers, and students are now referred to the new department for consultation services. New staff members were hired to work in this department.

The librarians stationed in departmental libraries found that they needed additional skills. To feel more comfortable talking to researchers about their data needs, subject librarians sought training opportunities and made efforts to increase their subject knowledge. This is viewed as a critical step to becoming embedded in a department and to being considered as a potential research partner.

Supporting e-science was viewed as both an added responsibility and a change in the traditional role of librarians. With the emphasis on all things electronic and with fewer faculty and researchers coming into the physical library, e-science programs and services were seen as an opportunity to reach new faculty members, students, researchers, and especially administrators at the university and department level.

**Future changes.** The director indicated there was more work to be done in order to meet the goal of being a critical partner in the university's efforts to provide data management services, specifically to develop the domain knowledge necessary to be an effective member of the research team, and the success measures for the programs and services that are currently

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<sup>8</sup> Citation withheld to anonymize the library.

being offered to ensure that they are meeting the needs of the research community they are seeking to serve.

**Experience of change.** The changes resulted in librarians assuming new attitudes and views of library services; the traditional roles of the past were being reinvented. It has also necessitated that they learn new skills and be willing to learn some of them on their own. Overcoming the fears often associated with change was not an issue; library faculty willingly embraced the new changes. However, challenges remained due to resistance outside of the library as faculty members were reluctant to share data and seek outside help to manage project data. The library sought willing partners and began their transformation slowly.

**Type of change.** There was agreement that the changes occurring in the library were evolutionary in nature, but for some librarians it felt more revolutionary, like “rapid little steps.” There was no consensus among the librarians as to whether the change was primarily of content (type of materials, skills used) or context (environment, new skills needed). One librarian stated that the changes were primarily due to outside forces in technology and how scientific research is conducted, and the library simply reacted and was not proactive.

### **Role of Administration**

The roles of library administration were twofold. First, the library director secured funding which would pay for staff, training, and other resources needed to develop and provide services; second, the associate director headed the programs and services. When asked who provided the leadership across the institution to implement e-science, the associate director indicated it was the library; the director stated that leadership was being shared among the Office of the Vice Chancellor for Research, the Chief Information Officer, and the library. Both the director and the associate director maintained that a shared vision was created and implemented.

**Library vision statement.** Library A has a formal vision statement which focuses on facilitating the intellectual exploration of the faculty, staff, and students of the university, the state, and scholars and visitors from across the country and around the world through its leadership in the:

- design and delivery of exceptional user services;
- acquisition and curation of extraordinary research collections;
- identification and application of new information technologies;
- research and development into innovative library services and information technologies;
- and
- promotion of substantive and sustained collaboration with partners on campus, among the local community, across academic institutions, and around the world.

Library administration views the e-science initiatives that the library is leading as being in alignment with the overall library vision. The goal of the e-science program is to support digital scholarship by meeting the emerging needs of students and scholars engaged in e-science and other forms of digital scholarship. The library does this by establishing programs that support access, dissemination, preservation, and curation of digital content created, managed, or acquired by the library. The library is investing in new positions or re-allocating resources from among existing human resources toward data curation activities. In addition, the library is actively promoting outreach, acquisitions, and scholarly support programs associated with the data services it provides.

**Leadership challenges.** Both the director and the associate director identified several challenges to implementing the changes associated with providing e-science programs and services. The associate director saw the primary challenges to be raising awareness of the issues

associated with data management, and customizing services to match the needs of each group. The director thought initially that identifying the appropriate role of the library in relation to other stakeholders who were providing services was a challenge, along with educating faculty, developing staff expertise, and finding ways to help those researchers who are not able to manage on their own.

**Communication.** The primary modes of communication used within the library to communicate the importance of e-science are the annual state of library address, given by the director, and the library strategic plan. External to the library, library administration connects with other faculty, researchers, and members of university administration by participating on campus committees which are concerned with data management issues. This participation at the university level serves to raise awareness of the libraries role in e-science support.

**Empowering staff.** Library administration empowers staff by providing funding for continuing education and any needed resources, such as hardware, software, and appropriate temporary staff to assist with project work. Library staff are also encouraged to pursue their own research to help advance the library profession. Ultimately, staff are empowered to assume new roles as faculty ask them to take on new tasks and develop new services.

**Sustainability.** In order to incorporate the recent changes into the culture of the library, library administration has had to make the new e-science programs and services an integral part of the library's core mission. Data management and e-science goals are incorporated into the reporting and evaluation structure. When a library position is vacated, administration actively seeks out a new staff member with appropriate skills and is interested in data management. The library also provides a number of internal opportunities to learn about data management and

develop new skills through the provision of workshops and collaboration with local champions and mentors.

**Hurdles to implementation.** Sustainability is a long-term concern for library administration, specifically because of limited resources and the lack of technical expertise among library staff. Library administration continually modifies job descriptions and seeks out new candidates to fill gaps in technical expertise. As well, the lack of clarity on how to manage this new direction is a concern. There is strong support across the university for the library to take an active role in setting a direction for the institution. How the new direction affects the long-term internal management of the library is not as clear as staff are reassigned to assume new roles and their work takes them out of the library and into research departments.

### Summary of University A

Table 3.3 summarizes the unique attributes of University A as discussed above.

Table 3.3

#### *Unique Attributes of University A*

Category	Attribute
Role in policy	Setting metadata standards
Services provided	Facilitating online journal publishing
Implementation facilitators	Open access movement
	Making it a priority/making time
Implementation barriers	Focus on storage
Changes occurring	Emphasis on electronic
Future changes	Develop success measures
Desired skills	Advocate for library and self
	Explain the issues
Library/librarians role	Formulating policy
Role of library administration	Secure funding
	Lead programs and services
Leadership challenges	Helping those who can't help themselves



Table 3.3 (continued)

*Unique Attributes of University A*

<b>Category</b>	<b>Attribute</b>
Sustainability	Continuing education Champions Integrate into workflow
Leadership hurdles to overcome	Lack of technical expertise Knowing how to manage new direction

**University B**

The library administration has been thinking about and planning for e-science for more than fifteen years as it closely monitored the rapidly changing trends in the conduct of scientific research. Formal programming was put in place in 2008. The library's involvement in e-science can be attributed to three factors. The first is people, both faculty and library staff. The faculty were encouraged to take initiative, accept risk of failure, be leaders in their respective fields, and seek out mutually beneficial collaborations as appropriate. Faculty acknowledged the expertise the library offered. In turn, key library staff embraced the entrepreneurial culture (a focus on creativity and the pursuit of new opportunities) they work in and created programs and services that met their clients' needs. The second factor is the library's history of advocating for information policy and management on campus, such as advocating for open access and providing document repository systems. Third, the library is viewed as a center where innovative technology can be developed, tested, and implemented.

**Data Gathering**

The investigator conducted a personal interview with the library director, two telephone interviews with the associate director, and a focus group interview with ten librarians who provide e-science services. The director was unable to secure access to an institutional

representative or to any strategic partners for interviews. However, the director provided the investigator with transcripts of recent interviews conducted by librarians with the vice president for research and associate provost,<sup>9</sup> the head of Information Services and Technology,<sup>10</sup> and a principal research scientist. In addition, the investigator consulted university and library strategic planning documents, online press releases from the university's administration, scholarly articles written by librarians from the institution describing services, and web-based chronicles in the form of news articles and blog posts to expand her understanding of the interview participants' comments. The following summarizes the findings.

### **Institutional Perspective**

University research activities range from individual projects to large-scale, collaborative, and sometimes international endeavors. The university provides faculty with the infrastructure and support necessary to conduct research; however, individual researchers often manage their own computing resources and provide for their needs in their local laboratories, resulting in a decentralized approach.

From the university perspective e-science is not just the data an individual researcher generates. It also includes the science performed using digital tools to manipulate digital data, bringing together data and other objects of scientific investigation from a variety of sources. The

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<sup>9</sup> The Vice President for Research (VPR), who has overall responsibility for research administration and policy, oversees more than a dozen interdisciplinary research laboratories and centers. The VPR is responsible for research integrity and compliance and plays a central role in research relationships with the federal government, industry, foundations, and international sponsors.

<sup>10</sup> According to the Information Services and Technology (IS&T) public website, it "provides foundational IT services that make it easy for the university community to do its work: communicate, collaborate, and interact locally and internationally. It provides the technical resources, services, and support to help everyone work smarter, faster, and safer. From helping professors collaborate on research, to helping students get the software they need for class, to helping protect the network from cyber attacks, IS&T is the information technology backbone that supports the university." (Citation withheld to anonymize the library)

university has a role in preserving data that may provide additional value in the future, but the expense associated with doing that is high and requires a change in culture and a unified vision.

Participation varies across the disciplines, as the cost associated with more detailed record keeping and preparing data for other users versus the future benefit of long-term preservation is determined by individual researchers. At the administrative level, university administration sees profound merit in a policy of open research and free interchange of information among scholars, but acknowledges that there is no clear articulation of what the local impact is and what the needs are when it comes to the management of research data.

### **Institutional View of the Role of the Library in Supporting E-Science**

University administration views the library as having a role in supporting e-science on campus. It looks to the library to provide reports on what is happening at other universities, to be a source of credible information, to be a unit that can bring different groups together, and to be a resource for developing and supporting new data management systems. The administration considers the library as a partner that can assist in identifying possible solutions for data management on campus.

A few individual faculty members have come to the library for help in preserving selected datasets. In these instances the library is viewed as an organization that faculty can work with to discuss long-term data preservation issues and offer reasonable solutions. Yet, the intense decentralization and independence of researchers has the majority of them seeking ways to solve their own data management needs.

### **Library-Based E-Science Programs and Services**

The library had extensive involvement working with geographic information system (GIS) datasets and social science datasets. Those experiences led the library to hire a data

librarian and begin offering data management consulting services. The emphasis was placed on the opportunity for collaboration, whether the collaboration focused on humanities, social sciences, or scientific data. Table 3.2 lists library e-science programs and services.

**Education.** The library designed a website that explains on the landing page why data management is important. The content has been as comprehensive as possible so that researchers and students can address their research needs independently, whenever, and from wherever. Topics covered on this website include how to evaluate data needs, meet funding requirements, design a comprehensive data management plan, develop documentation and metadata, organize data, create backup and security plans, and share and cite data. The website also introduces legal and ethical issues that need to be considered.

The educational effort is not only focused on the research community. Librarians are encouraged to seek opportunities to further their understanding of the evolving research data management needs of campus researchers and further their own education and expertise. Librarians who are working to provide e-science programs and services have also taken local and national roles in helping to educate other library professional and students in how to develop and provide e-science programs, specifically data management services. Those looking to learn about data management often consult the information posted to the web by the library or invite a representative from the library to speak at local or national LIS conferences.

**Policy.** A number of librarians have helped to establish national metadata standards related to GIS. They have assumed roles on national committees and have publicly commented on proposed standards. At the institutional level, librarians participate on two committees that discuss policy issues related to data issues: the Committee on Intellectual Property, and a temporary committee that recommended policies regarding the use of restricted data.

**Research.** In order to secure external funding, the library has actively sought out opportunities to partner with researchers. A number of grant proposals have been submitted in which library personnel are listed as contributors or in which library services are a critical component.

**Services.** Besides the education services mentioned above, the library also provides outreach services to researchers to raise their awareness of both best practices for data management, and the resources and services available in the libraries to help them manage and archive their data. The library also provides an institutional repository for documents. Additional services include identifying tools and resources to help researchers manage and archive their data, create permanent URLs and digital object identifiers (DOIs), and comply with funder and publisher requirements. Outreach methods include self-help tools and information, data storage solutions, and tailored individualized consulting over the course of a research project.

Data services include data in any format, such as numeric, geospatial, text, images, audio, video, and software. These data can be either primary (directly collected by the researcher) or secondary (originally collected by another researcher but used by someone at the university). The working group provides established services and undertakes a limited number of experimental projects. Consulting services are targeted to members of the local research community.

**Delivery.** In place of forming a new department, the library established an internal research data management working group as the central service unit for data management services. The group consists of a subset of subject liaison librarians interested in data management. The members gather and discuss data related programs and services and support one another as they seek out collaborations with researchers. The library has created an extensive website to serve as a central place for researchers and students to learn about data management

practices. In addition, the library works one-on-one or in small workshops with researchers and students.

**Resources needed.** The library places a high value on staff who are technically adept and like to learn. Staff also need to have good interpersonal skills and be willing to leave the library to work with researchers as partners. In addition to skilled staff, the library must have the appropriate technology to meet the data management needs of the research community. This includes analytical software, high-end library workstations, video conferencing, a high-performance computing center (local or in the cloud), and shared repositories and preservation facilities to store data. The library provides collaborative areas for researchers to work together. It also purchases datasets as part of the collection development policy.

**Implementation facilitators and barriers.** A major facilitator of the library's e-science outreach programs has been key personnel who are continually monitoring trends in e-science as well as changes in research processes and data management. These librarians press the need for the library's involvement and take the initiative upon themselves to discuss the issues with other library staff and seek to influence library administration. Another important catalyst came when library administration formally assigned the working group to take up the topic of e-science and data management. With that came formal authority to act on behalf of the library to develop new programs and services, as well as recognition that data management was now considered part of the librarian's official job description. The primary barrier to expanding programming and services has been resource constraints, particularly reductions in the library budget.

### **Changes Occurring in Order to Implement E-Science Programs and Services**

The changes that have occurred have been manifested in different layers of the library. At the highest level, getting involved in e-science and data management has defined a new role for

the library. The library is now being viewed less as a repository of print materials and is starting to be recognized for the unique skills and depth of knowledge librarians can bring to the research team. Operationally, the library reorganized and restructured departments and services. Outside forces also contributed to the library's need to restructure, but the administration specifically wanted to leverage library staff expertise to meet the new demands for data management services.

As part of the reorganization process, the data management working group was formed. New positions, in which data services were a key component, were designed and recruited for, and in the case of any staff turnover, previous job descriptions were updated to address the technical and data skills the library wanted in the staff.

At the point of service, librarians who were interested in getting involved in data management found that they needed additional training on metadata standards and new subject knowledge in order to work more closely with researchers and their datasets. Working with data was viewed as a major change in role for many of the librarians because this was the first time they were asked to work with a changing product (as research data moves through the research cycle its characteristics and values changes). As a result of this new role, librarians found that they were now reaching out to and working with a new group of faculty members, students, and administrators.

**Future changes.** The library administration is working to engage the necessary stakeholders on campus and guide the conversation; the library wants to be seen as a key player. It is critical that all the stakeholders have a clearer understanding of roles, responsibilities, and the various support services available on the campus as a whole. The emphasis is on developing a better partnership with the Office of Sponsored Programs and improving the relationship with

the vice president for research. The library wants to have affiliations with departments such as Information Services and Technology and other relevant players. Due to the decentralized nature of the institution, the major goal of the library is to foster better collaboration with the key central services that support the research endeavor.

Library administration sees the new environment into which libraries are moving as fundamentally and profoundly volatile. Many libraries are reacting to what is going on among the major information providers such as Google and Microsoft. Before major corporations start to develop new tools that support researchers data management needs, the library wants to have firm relationships and be recognized across the institution as an important asset available to all. The library administration continues to monitor and think about technology in terms of major changes every two to three years.

**Experience of change.** The librarians in the focus group interview viewed e-science programs and services, specifically data management, as an added responsibility; however, they felt as if the initiation of and momentum behind the changes were part of a grassroots effort in which a select group of librarians moved in this new direction and became submerged in data management. Over time, with the support of library administration, what started as an informal interest became a formal library-wide initiative. The changes experienced by the librarians have created opportunities for those who have previously worked independently on specific tasks or with pre-determined departments within the library to form new working relationships, across the university, and with external organizations, such as other university libraries.

**Type of change.** The library administration categorizes the changes as revolutionary because faculty are being asked to think about using information resources in a new way, and the library is challenging its traditional role in that process. The administration also characterizes the



changes as bold as the library takes a leadership role at the national level. Librarians describe the changes as revolutionary because they are working with new content in a new way, and the context in which they work is changing. However, there was consensus that many of the changes that had been implemented were well discussed and processed, in essence providing a framework and increasing the chances of success, and resulting in the changes being incorporated slowly over time. Participants in the focus group interview think that they are so immersed in the changes that it is difficult to categorize these changes as transformational; that characterization, they believe, could only happen in hindsight.

### **Role of Administration**

The primary role of the library administration has been to provide a framework for the new direction in which the library is moving. The goal is twofold: (1) people will see how the work they do fits in with the desired future, and (2) all library staff will work together and be informed about what other staff members are doing so that when a new opportunity arises everyone will know how to handle the inquiry or to whom to refer it.

The library, having strong support from university administration and the respect of the faculty, is often left alone to provide solutions to self-identified problems. As a result, the library, in the institutional context, is viewed as leading from behind in that it is subtly convincing people of the importance of data management and, through education, helping to build organizational capabilities so that researchers can make informed decisions. The library tries to anticipate university needs and relies on knowing the best timing with which to deploy new services for maximum impact.

**Library vision statement.** The vision for the library is shared and developed with participation by library administration and staff. The vision was formulated with a user-centered approach and in partnership with the faculty and seeks to:

- enable seamless discovery and access to scholarly information sources;
- manage and preserve knowledge, with an emphasis on locally-created content;
- provide faculty, students, and staff with expert support and training to find, evaluate, manage, and use resources;
- create high-quality spaces for both reflective and collaborative work and study; and
- lead initiatives to inform and shape the future of libraries and scholarly research.

With respect to e-science the goal is to create a service model in which the library becomes an agile, creative, and data-driven organization that facilitates discovery, manages knowledge, and provides faculty, students, and staff with expert support and training to find, evaluate, manage, and use library resources in support of e-science.

**Leadership challenges.** Challenges at the institutional level include role identification both for the library and other service centers on campus, such as information technology services. It has also been a challenge for campus network services to manage the amount of data that are produced daily and to identify and build a common delivery infrastructure in such a decentralized institution. Internal to the library, the challenges have been to balance the entrepreneurial culture among employees, who have been encouraged to develop new and innovative programs and services, with ensuring that engaged staff members continue to work towards the mission and shared vision of the library. It has also been a challenge to raise awareness, manage competing priorities, and develop a core set of services to meet the needs of many, as opposed to individual, researchers or research groups.

**Communication.** The library administration uses staff meetings to communicate the importance of e-science and data management. There are ongoing discussions articulating where the library is headed, and reinforcing why that direction is important. These events are followed up by all-staff e-mails and newsletter summaries. All planning and communication are backed up with allocation of resources around identified priorities. The director helps staff visualize the new direction and discuss where they see themselves fitting in. Staff are offered supplemental training to develop any new skills needed to be fully functional.

**Empowering staff.** Staff are empowered by having the latitude to explore new opportunities and suggest new ideas; they are encouraged to be innovative. There is a substantial rewards and recognition program. Through clearly defined roles and responsibilities, librarians can develop new relationships and partnerships outside of the library.

**Sustainability.** The administration acknowledges the hard work it takes to stay focused and deal with new challenges. Staff are mentored to deal with such challenges in the most systematic way possible; in many instances they are asked to rise to the challenge and deliver their best work. Through annual evaluations they are reminded of their tasks at hand and encouraged to be innovative and take calculated risks.

**Hurdles to implementation.** The main hurdle for library administration has been the limited amount of financial resources available for use and trying to match these resources with user expectations and demands. The pace of the institution is fast and the library must continually be ready to anticipate and respond to the latest changes, while maintaining a strategic model of library services in which the library proactively engages the community and not simply responds to the latest trends. As well, working in a constantly changing environment can be difficult for some staff to adapt to. The administration acknowledges that dealing with staff

resistance to the fast pace of change is a hurdle that must be acknowledged and overcome on a regular basis.

### Summary of University B

Table 3.4 summarizes the unique attributes of University B as discussed above.

Table 3.4

#### *Unique Attributes of University B*

Category	Attribute
Implementation facilitators	Expected as part of job Having formal authority Key staff
Changes occurring	Working with a changing product
Experience of change	Grassroots effort Formalization of what was already being done
Role of library administration	Provide framework Show people how they fit in
Leadership challenges	Identifying institutional roles Identifying common infrastructure services Balancing librarian freedom w/ going in right direction Amount of data Competing priorities Building infrastructure
Communication methods	Training
Sustainability	Staying focused Dealing with challenges rationally
Leadership hurdles to overcome	User expectations / demands Pace of institution Transitioning to a contemporary model of service Cost structure of licensed resources

### University C

The library has been involved in e-science for nearly a decade. The catalyst for its involvement is attributed to the arrival of a new director who emphasized the need for the library

to support the research community more, and engage in its own research related to library and information science. These two initiatives were launched at the same time that faculty from across the institution started asking for help related to data management, the proper application of metadata standards, and the long-term preservation of data associated with a major grant. These were areas which the institution, specifically Information Technology (IT)<sup>11</sup> services and the Office of the Vice President for Research<sup>12</sup> recognized as expertise held by the library. The library, in turn, wanting to be better placed strategically within the university, seized the opportunity for collaboration. Recent requirements such as those of the National Institute of Health (NIH)<sup>13</sup> and the NSF<sup>14</sup> for data planning have solidified the library's participation.

### **Data Gathering**

The investigator conducted four interviews; one with the associate vice president for research, and one each with three strategic partners (two faculty members and one representative from IT). Library interviews were conducted with the library director, two associate library directors, one data librarian, and one subject librarian. In addition, the investigator conducted a focus group interview, but only with three librarians who provide e-science services participated. The investigator consulted university and library strategic planning documents, online press releases from the university's administration, scholarly articles written by librarians from the institution describing services, and web-based chronicles in the form of news articles and blog

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<sup>11</sup> IT services is responsible for the management of all IT resources including administrative systems, enterprise applications, cyberinfrastructure for research, IT infrastructure, IT networks and security, academic and classroom technologies, IT support and customer relations, and IT communications.

<sup>12</sup> The mission of the Office of the Vice President for Research (OVPR) is to support faculty members in developing research programs and producing competitive research proposals. The OVPR assists in locating funding opportunities, proposal preparation, and providing support for regulatory requirements.

<sup>13</sup> The National Institutes of Health (NIH) has developed a data sharing policy that went into effect beginning October 1, 2003, for applicants seeking NIH funding of \$500,000 or more in direct costs in any one year. The policy expects final research data, especially unique data, from NIH-supported research efforts to be made available to other investigators. It includes data from: basic research, clinical studies, surveys, and other types of research (National Institute of Health, 2003).

<sup>14</sup> See footnote 4, Chapter 3.

posts to expand her understanding of the interview participants' comments. The following summarizes the findings.

### **Institutional Perspective**

The institution regards e-science as research that is undertaken using intense computation to perform many experiments simultaneously, to generate data which can be manipulated by computers through simulation and visualization, and to share/mix/reuse those data to explore new problems. The university's goal is to provide the infrastructure needed to support discipline-based research and multidisciplinary collaboration among researchers for breakthrough advancements in research programs. These large-scale multidisciplinary research programs, dependent on computational research, are primarily conducted in the physical, life, and environmental sciences.

The university's mission is to facilitate learning, discovery, and engagement. The university administration views the library as a critical resource to enable discoverability and availability, and to establish provenance<sup>15</sup> in the area of e-science. The university is aware of the increased need to have processes in place to manage the large amount of data produced and is concerned that without proper planning the institution will soon be overwhelmed with research generated data. The administration is looking to the library for that preparation and planning to avoid such a situation.

Three resources were identified as essential to providing e-science programs and support: equipment and infrastructure, people, and time. Having in place the proper equipment and infrastructure such as storage systems, search and retrieval interfaces, and high-speed computing options, along with backup systems, is essential. It is also crucial to have the staff expertise to set

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<sup>15</sup> Provenance in the context of e-science and data management refers to the history of how the data were acquired and subsequently processed (Dinov et al., 2010).

up and manage these systems. Simply adding these tasks to the workload of current staff is not an option, as they do not have the time for such a major undertaking.

Three campus departments were also characterized as critical: IT to provide the infrastructure and technical expertise, the Office of the Vice President for Research to secure funding and advocate for researchers' needs, and the library to provide expertise in organization, management, and preservation of data, as well as the vision and managerial leadership to coordinate the various stakeholders.

Along with these resources and partners, the success of various e-science projects is attributed to several champions, and there are success stories associated with early projects. Faculty and researchers have seen high-profile projects which have involved IT, the Office of the Vice President for Research, and the library thrive, and, as a result, have been willing to work with these partners to duplicate their achievements. One barrier identified by university administration is that faculty and researchers use the physical library less due to the vast number of electronic resources; library staff, therefore, are not in close physical proximity to the end users. This can make it difficult for the library to ensure that faculty are aware of the services that the library offers.

### **Institutional View of the Role of the Library in Supporting E-Science**

When the new library director arrived, the institution and strategic partners indicated that it was critical to have the library involved from the beginning in e-science initiatives because of the unique skills and expertise found on staff. The library is regarded as a resource offering expertise in tagging, classification and subject indexing, authority control, metadata, and the publication process. It is viewed as having brought organization to a number of large projects by developing and implementing standards and authoritative auditing procedures. The library is

seen as a partner providing strategic advice on how to create a modern data management system that is flexible and can be used by a variety of disciplines. Library staff have identified system requirements and written customized code to meet those needs. The library is also seen as an active research partner because it facilitates communication between the disciplines and knows how to deal with the issues of terminology that become more important when datasets are created and shared. Lastly, the library is considered a peer in co-authoring grant requests, presentations, and publications, as well as leading its own local and national research and grant program.

Library staff are seen as experts at converting data that are locally understandable and locally accessible into datasets that are universally understandable and universally accessible. The relationship between researchers and librarians has evolved over time; what started out as an occasional, lower-grade effort has developed into a higher-grade, collaborative effort to try and advance common interests. The library staff are described as being extremely patient and willing to dedicate time and resources to the development of new collaborations by participating in brainstorming sessions and participating in projects that have grown from ideas into fully written proposals.

### **Library-Based E-Science Programs and Services**

The library began its work in e-science slowly. The first step was to develop the staff's comfort level by supporting training requests and professional development activities. After staff had a better idea of what e-science was about, the library administration began to build staff confidence and encourage them to talk with potential partners. Finally, administration supported any additional subject training that was needed to increase overall staff competence.



Early activities included developing educational classes for faculty and researchers on data management, expanding the concept of reference services to include a data consulting service, and offering staff time for collaboration on projects outside of the library. In 2004, the library began developing data archiving options for researchers and examining how researchers manage data throughout the research process. Table 3.2 provides a full list of library e-science programs and services.

**Education.** The library provides learning opportunities for librarians. There is cooperation among the librarians to educate one another, and there is also support from library administration to hire outside experts to help instruct librarians in new or emerging areas when needed. Subject librarians have the option to team with a data services librarian when discussing data management planning issues with a researcher. The intention of this arrangement is twofold. First, by pairing a more experienced data services librarian who has worked on a variety of data projects with the subject expertise of the liaison librarian, the two together can offer the researcher the most complete and current recommendation to meet data management requirements. Second, this type of partnership provides a learning opportunity for everyone involved. The subject librarian becomes more comfortable conducting a data interview so that he or she can work independently in the future, the data services librarian learns about the specific data requirements of a discipline, and the researcher has a team of librarians with whom to collaborate and discuss options.

Formal educational workshops for researchers, faculty, and students are focused on issues such as working with sensitive research data, in which researchers are legally and ethically obligated to ensure that confidentiality is maintained. Library staff have also developed in-depth instructions on citing and the use of secondary research datasets.

**Policy.** Individual researchers and university administration have turned to the library for advice on policy and procedures. Individual researchers have sought out library services to assist them in managing the data production process, providing long-term access to and preservation of research data, and complying with external data sharing requirements. In these instances, the library is viewed as the most authoritative expert on campus.

**Research.** The library's wants to establish itself not only as a resource, but also as a reputable research center that takes the lead in investigating issues and problems related to making research data available. It collaborates to develop solutions for research data curation, management, dissemination, and preservation. As a research center, the library has applied for and obtained numerous grants related to the study of data management and curation. It has also shown that it can be an effective contributor to research projects originating outside of the library. Between 2005 and 2010 the library's faculty partnered with 68 faculty members in 31 departments to write 95 grant proposals. A small percentage of these were funded, but the number of successful grant submissions has increased over time.

**Services.** The services provided for faculty, researchers, and graduate students are categorized into two levels: consulting and collaborating. At the consulting level, librarians, primarily subject liaisons, work on developing a data management plan, identify relevant data repositories, guide the preparation of data for deposit, and find and make use of metadata standards, ontologies, or other tools and resources to manage, share or curate data. At the collaborating level, dedicated library staff (not necessarily those with a master's degree in library and information science) work with researchers to integrate data management, dissemination, or curation into research workflows; identify and implement data management and curation solutions that are tailored to the needs of a laboratory or research project; increase the discovery

and utility of data through the design and application of metadata; enhance the dissemination of data through the application of standards as OAI-PMH<sup>16</sup> and promote the use of linked data;<sup>17</sup> and add value to data so that others can cite them through the use of DataCite's digital object identifiers (DOIs).<sup>18</sup>

The library provides a number of technological solutions. These include an online, collaborative working space with data-sharing platforms to support the data management needs of researchers and their collaborators. Examples of data that the library staff are working with include spreadsheets, instrument or sensor readings, software source code, surveys, interview transcripts, images, and audiovisual files. The library also supports a traditional institutional repository that highlights university scholarship of various types (e.g., working papers, journal articles, and dissertations and theses).

**Delivery.** The library director is a strong advocate who initiates and promotes the library data management services and encourages future partnerships from across the university. The library uses its website to deliver educational materials on relevant data management issues. Initially a few dedicated staff, who were hired for this specific purpose, delivered the library-based e-science programs and services. These staff members proactively engage with faculty to discuss collaborative opportunities. Over time, an increasing number of subject librarians have

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<sup>16</sup> “The Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) is a “low-barrier mechanism for repository interoperability. *Data Providers* are repositories that expose structured metadata via OAI-PMH. Service Providers then make OAI-PMH service requests to harvest that meta” (Open Archives Initiative, n.d., para. 1).

<sup>17</sup> “The term Linked Data refers to a set of best practices for publishing and connecting structured data on the web.” (Heath, 2009, para. 1).

<sup>18</sup> DataCite is “an international organization which aims to: establish easier access to research data; increase acceptance of research data as legitimate contributions in the scholarly record, and to support data archiving to permit results to be verified and re-purposed for future study” (<http://www.datacite.org/faqs>). “The DOI System provides a framework for persistent identification, managing intellectual content, managing metadata, linking customers with content suppliers, facilitating electronic commerce, and enabling automated management of media” (German National Library of Science and Technology, n.d., para. 4).

become more comfortable discussing data management issues with their faculty contacts, and these librarians serve as additional contact points to initiate data management discussions.

**Resources needed.** The most valuable resource identified by the library is appropriate staff. A thorough review is conducted of each position that becomes vacant, and descriptions may be rewritten to incorporate the desired qualification and skills. The preferred list of skills and knowledge areas include: interviewing skills, project management skills, interpersonal communication, social skills, a science background, technical skills, a willingness to learn and to approach people, self-confidence, and an understanding of the research process. Hiring library staff to meet these requirements has been the priority, along with retraining current staff, so that the library will have the skills and knowledge to meet future needs.

Additionally, the library has developed a framework for selection, acquisition, de-acquisition, and de-selection policies related to datasets and the institutional repository. The library is incorporating policies for long-term preservation at the point of acquisition, rather than waiting to make a decision in the future or in reaction to some other event. Through an analysis of current collection policies the library is hoping to find areas where the process can be improved in order to manage this additional collection development work.

The library has three repositories which provide faculty with long-term preservation and access: archives, document, and data. Some of these systems were developed in-house, others purchased, and some are based on open-source software.<sup>19</sup> The library is not fixated on developing new tools; it is willing to use what already exist and to test their limits. Library administration also believes that beyond the development of new technologies there is a role for librarians in teaching researchers how to use existing technology, such as locally developed

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<sup>19</sup> Open-source software is computer software that is available in source code form. The source code and certain other rights normally reserved for copyright holders are provided under an open-source license that permits users to study, change, improve and at times also to distribute the software (Open Source Initiative, n.d.).

tools, and free or commercially available productivity software, such as citation management tools.

The library has not intentionally made any modifications or renovations to its current space to accommodate e-science programs and services; the primary work is done outside of the library. Routine updates to facilities and computing equipment have been made but not as a direct result of e-science.

**Implementation facilitators and barriers.** Although library administration has always considered the library to be well funded, it still faces issues associated with the constraints placed on those resources; for instance, there are funds that must be spent on traditional paper collections, small departmental libraries, or staff working in protected para-professional positions. The number of staff considered experts in providing data management consultations is limited. Above all, the librarians feel as if they have no “best practices” to follow since they were among the first to offer e-science programs and services. Despite having nothing to model programs and services after, the success of the local programs and services has been attributed to individual initiative, a strong desire for collaboration within the library and across campus, the support of library administration, and having vocal champions outside of the library. E-science is a central part of the library’s strategic plan that was shared across the university. The library director promotes the e-science related services outside of the library during meetings, and specifically during discussions among researchers about implementing the NSF data management requirements.

### **Changes Occurring in Order to Implement E-Science Programs and Services**

With the arrival of the current director, the library began a strategic planning process that would allow it to advance ground-breaking ideas by focusing on service, collaboration, and

research. The goal was to produce innovative products that would serve as models that could be adopted by other libraries that wanted to become involved in e-science. The library specifically sought to further its role in interdisciplinary research by increasing campus awareness of the value added by its participation in interdisciplinary research, the number of collaborative grant proposals, and the alignment of collections and information resources to support interdisciplinary research.

To achieve this, a new department was formed with specific goals: to advance understanding of issues in curating research datasets in distributed environments; to build partnerships with researchers, technologists, and librarians across the university; and to develop innovative, applied and disciplinary-based solutions for data management, discovery, and dissemination. Four library researchers were assigned to this new department and were asked to work closely with subject liaison librarians throughout the libraries and to address problems of data curation. Two of the four research positions are recent hires (two involved re-assignment of existing staff) that were created and designed specifically to work in the new department. An updated reporting structure was put in place and new workflows across the library were implemented to leverage the expertise of this specialized unit; any subject liaison could bring issues of data management to the new department and receive assistance in supporting their researchers.

Each position that is vacated due to staff turnover is re-examined to include responsibilities associated with data management and to require specific skills useful for working in that area. Staff who were already working in the library were encouraged to seek training opportunities and acquire the necessary skills to be effective.

The goal of collaborating with researchers on funded projects was not limited to this specialized unit. All librarians were asked to take on this role and seek to become embedded in a department or a research project. For many this required additional knowledge, skills, and abilities. The librarians worked together to develop training materials that were posted to the web for easy access for those librarians with questions.

The library believed it was important to make the collection of locally-developed resources a priority; this included locally-produced publications, technical reports, archival materials, and data. A data repository was developed to facilitate the discovery and preservation of such works.

**Future changes.** In order to meet its strategic goals to become part of the campus-wide research process, the library began to rewrite job descriptions for newly-vacant positions to include data management duties. In the future it is anticipated that every position will have some aspect of data management included in it. Providing supplemental training for librarians in the area of data management, project management skills, and knowledge of the research process began in 2006 and continues. Moreover, library administration is closely monitoring how closing or combining departmental libraries will affect the relationship librarians have formed with researchers who were formerly situated in close proximity and readily available.

**Experience of change.** The librarians indicated that there was an adjustment period through which they had to go. New attitudes and views were required in order to embrace this new role. They found it difficult to meet these new expectations early on, indicating that there were not many opportunities for success, and overcoming faculty resistance was difficult. However, they did find this offered a new way to engage faculty. The librarians felt that it was important to seek training opportunities and take the extra time needed for education in order to

overcome the large learning curve and be successful. The consistent message from administration that e-science and data management were an important part of the library's future was a strong motivating factor.

**Type of change.** The library's strategic plan calls for the librarians to take on a transformed role. Discussions with librarians indicated that the ideas that are being put forth from library administration are revolutionary, but in fact implementation happened slowly over time and the changes have been much more incremental. It has taken time to acquire and apply the necessary resources, there was a period of experimentation, and success has been limited. There was a feeling that it was a "hurry up and wait" situation wherein the library was doing a lot of preparation, yet faculty were slow to embrace the concepts of data management and sharing. One librarian commented that the transformational changes have taken place outside of libraries, and librarians are simply reacting.

### **Role of Administration**

Library administrators identified multiple roles for themselves. The primary one was to set the vision, to further the library's role in interdisciplinary research, which the director and the associate directors did. The vision was characterized as a shared one conceived by all working together. Associated with that vision, the administration worked to secure funding, identify potential problems before they occurred, and made sure nothing fell through the gaps. Another role of administration is to help the liaison librarians to embrace the new tasks they are being asked to assume and to make sure they feel equipped and able to do outreach to faculty who are engaged in e-science.



**Library vision statement.** The library vision has multiple parts:

- to be recognized as an essential leader in the advancement of the university's core strengths and global mission;
- to lead in innovative and creative solutions for access to and management and dissemination of scholarly information resources;
- to lead in the provision of information literacy;
- to create leading edge learning spaces, both physical and virtual; and
- to be regarded as a leader in the national and international research library community.

**Leadership challenges.** The challenges associated with these roles involve librarians not having the necessary knowledge, skills, and abilities. It has been difficult for the administration to allow staff to explore problems and questions on their own and to not step in and solve problems for them. A conscious effort has to be made to allow staff the time needed to develop the required expertise.

**Communication.** The library administration has used the strategic planning process to communicate the importance of e-science initiatives, including goals such as “lead in data-related scholarship and initiatives” and “increase the participation of Libraries’ faculty as partners in multidisciplinary research, applying library, archival, and information science principles.”<sup>20</sup> Progress towards these goals is noted in the library’s annual report and communicated at all-staff meetings and during one-on-one conversations with staff. Likewise, the administration has sent a clear message of the importance of these initiatives by re-writing or creating new job descriptions to include e-science and data management.

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<sup>20</sup> Citation withheld to anonymize the library.

**Empowering staff.** Library administration is encouraging librarians to transition into new roles by letting them ask questions and express their concerns, and by providing the necessary education and resources to assume new responsibilities. The goal is to boost confidence. There has been an open call for participation: anyone interested in learning about data management and e-science is encouraged to get involved.

**Sustainability.** The library administration has strived for slow strategic growth. It has needed the time to obtain the necessary resources, develop staff, and plan for the future. The approach has been to “do more – know more.” The administration has also been deliberate in its efforts to reallocate current staff and make sure that the right people are hired. Librarians explore and undertake new collaborations within the library and across the university.

**Hurdles to implementation.** The library administration has had to deal with the allotment of limited resources among competing priorities. As well, it has had to overcome staff resistance by developing comfort level and confidence. The administration has found that some on campus hold a traditional view of the library, and there is a need to overcome the image of the library as simply a repository of books. Additionally, not having the right tool for the problem at hand (e.g., managing a large dataset) has been an issue. Many of the desired tools do not yet exist. The library has had to decide whether it should wait for the perfect tool to come along or invest in developing applications in-house, such as a data repository that is scalable to handle the needs to the entire university.

### **Summary of University C**

Table 3.5 summarizes the unique attributes of University C as discussed above.

Table 3.5

*Unique Attributes of University C*

<b>Category</b>	<b>Unique</b>
Services provided	Facilitating online journal publishing
Implementation facilitators	Incorporated into strategic plan Support of administration People advocating for the library Collaborative Champions on campus
Implementation barriers	Expertise No best practices
Changes occurring	Acquiring new collections (datasets)
Future changes	Combining libraries Train staff for new work
Experience of change	Large learning curve Adjustment period Limited opportunities for success Consistent message – e-science is important Difficult to meet expectations early on
Skills	Interviewing skills Interpersonal communication Self-confident Willingness to approach new people
Library/librarians Role	Outreach Secure funding Contribute to research (LIS)
Role of library administration	Equip staff to do the new work
Leadership challenges	Allowing staff to learn for self
Methods used by administration to empower	Let people talk Open call for participation
Sustainability	Grow leaders for the future Do and know more Slow strategic growth
Leadership hurdles to overcome	Comfort and confidence of staff Campus perception of what a library is Having the tools

## **University D**

The library has been involved in e-science since 2000, and has always been expected to embrace the entrepreneurial culture of the institution. As a result, the library's long history in curating special collections earned it the reputation of being an expert in the long-term curation of large-scale datasets. Internally, library managers also thought it was important to help scientists and researchers manage their data, which includes preservation and curation, so the researchers can focus more on the science and the library can oversee data management issues. The library promoted itself as the organization that can do that. It markets itself as an organization that thinks about the long-term, focuses on preservation, has a sustainable source of funding; and operates under a service-oriented mission. These efforts resulted in the library director and an associate director being asked to be co-principal investigators and manage the data curation issues on a major national grant.

### **Data Gathering**

Interviews were conducted by the telephone separately with the library director and an associate director. In addition, the investigator conducted two focus group interviews by the telephone, but each with only three librarians who provide data services. The library was unable to arrange for interviews with strategic partners or any representatives from university administration. The investigator consulted university and library strategic planning documents, online press releases from the university's administration, scholarly articles written by librarians from the institution describing services, and web-based chronicles in the form of news articles and blog posts to expand her understanding of the interview participants' comments. The following summarizes the findings.

## **Institutional Perspective**

The university mission is to educate students and cultivate their capacity for life-long learning, to foster independent and original research, and to bring the benefits of discovery to the world. Data-driven science is a vital part of that mission and a priority across the institution. It is considered an important element of “signature initiatives.” The university usually has four or five such initiatives in process at any one time. One of the criteria for a signature initiative is that it needs to bring together at least three, preferably four or five, areas of the university, around solving a major problem. The library’s capability in supporting e-science means that it is part of these initiatives automatically. It was not even imagined that these signature initiatives could go forward without bringing new resources into the library or having the library as a full partner. The expectation of being involved is critical, as is the funding that comes from that involvement in order to expand services. The library began with e-science but it has since seamlessly expanded into service related to digital humanities, since this requires no additional resources.

## **Library-Based E-Science Programs and Services**

Given the potential scope and magnitude of data generated at the institution, the challenge was to develop a set of local practices, policies, and activities that reflected the diverse and dynamic need of the scientists and researchers. The goal was to incorporate enough flexibility to meet any future needs, as well as to eliminate the possible development of data and service silos. The library was looking to provide a sustainable data curation infrastructure. Faculty researchers were identified as the primary users and research support as the primary services to develop.

It is also important to note that the majority of services being developed by two departments (a digital library group and a data consulting group) were marketed as a centralized

campus service that is housed in the library, and just happens to also be managed and staffed by librarians. Some of these services, such as data archiving, are provided under a cost-recovery model.<sup>21</sup> A few liaison librarians were also working within their assigned departments to provide data services, but these projects tended to be smaller in scope and had a limited time commitment. This study focuses on the centralized services offered by the digital library group and the data consulting group. Table 3.2 provides a full list of e-science programs and services.

**Education.** Librarians working in the digital library and data consulting group are supported to attend conferences and meetings (local and national) to further their own skills and knowledge. The librarians are also encouraged to share what they are doing locally through presentations and publications. The digital library and data consulting group do not offer any formal educational programming. They serve as a resource for liaison librarians who are in need of consultation and can often get them started in the right direction when assistance is needed.

**Policy.** The library plays an important role on campus in setting and contributing to institutional policies related to data management, as well as in assisting faculty and researchers to comply with those policies. The library also has an important role in informing and educating the university community about new developments and changes in national data requirements, such as those issued by federal agencies and other funding institutions. Additionally, the librarians have taken lead roles in reviewing and contributing to setting national metadata standards that are used by libraries and subject-specific repositories around the world.

**Research.** The data consulting group's approach to research has been to partner with researchers and scientists on grants. To date projects have emphasized the development of automated tools, systems, and software to reduce the costs associated with converting print,

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<sup>21</sup> Cost recovery is a financial model in which fees/prices are adjusted for goods/services so all cost of operations and maintenance are covered for supplying the given goods or services (Malz, 2011).

audio, and video materials in digital form, and with curating content that is born digital, such as large-scale scientific datasets. These programs and activities emphasize a combination of custom technologies with strategic project management and planning.

The digital library group conducts research and development related to digital libraries in collaboration with faculty, librarians, and archivists within the institution and beyond. The members provide expertise to facilitate the creation of digital library materials and services and evaluate digital libraries through usability research and economic analyses. As well, they provide leadership in fostering an environment and culture which is conducive to advancing the library and university in the digital information age. Reports about the programs and services emerging from this group have been published in academic papers and featured in articles or news stories by national newspapers such as *The New York Times* and *The Chronicle of Higher Education*. Funding to support the research work has come from NSF, the Institute of Museum and Library Services (IMLS), and the Mellon Foundation.

**Services.** The data consulting group offers two types of services: consulting on data management and planning, and archiving of research data. As consultants, the group offers to identify and review researchers' data management and sharing options during and after a research project is completed. The consultants also guide researchers on appropriate content for a data plan to meet specific funder requirements, such as those stipulated by the NSF, as well as any university requirements, such as internal policies on access and retention of research data and materials.

The archiving services are closely tied to the data management and planning process. Throughout the planning phase, consultants review options for storage and access to data during the active collection phase of the research project. This review process also applies to the long-

term preservation of and access to the research data after the research project has been completed. Researchers are informed of any discipline-specific repositories that they might consider using, as well as local fee-based options associated with the consulting group or university. Local archiving services include long-term preservation of media (e.g., CDs and tapes), migration of file formats (e.g., spreadsheets and PDF files), and long-term storage options with access and retrieval through an archive system. This system uses persistent electronic identifiers, such as DOIs, which allow for easy citation and attribution of the researchers' shared datasets. The archive system can store cross-disciplinary data, has an integrated framework allowing for searching across the archive, and is designed to be a long-term preservation system. The selling point of the archiving service to faculty is that using a trusted digital repository<sup>22</sup> service passes responsibility of managing the research data onto a third party, and leaves researchers with more time to focus on conducting their research.

**Delivery.** The data consulting group works primarily one-on-one with researchers. Researchers are asked to contact the group at least two weeks ahead of their proposal deadline. A consultant meets with the researchers to discuss the proposal in development and to work through a pre-set questionnaire which was developed to gather and organize the relevant information needed for a comprehensive data management plan. After the meeting, consultants are available to review a draft data management plan, paying close attention to the data management requirements of the funder. Typically the review occurs within 24 hours of submission.

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<sup>22</sup> A trusted digital repository is a digital repository capable of reliably storing, migrating, and providing access to digital collections. Through an audit and certification process, repositories are confirmed to meet a set of criteria applicable to a range of digital repositories and archives, from academic institutional preservation repositories to large data archives and from national libraries to third-party digital archiving services.



**Resources needed.** The data consulting group places a high value on three main knowledge areas. First is computer and information science training. Data consultants are expected to have a background in computer science and/or informatics, and programming or data mining skills are preferred. This experience is seen as key in managing scientific data. Second, consultants are expected to have domain knowledge outside of library and information science, such as a master's degree in a scientific discipline or engineering. This contributes to the consultant's credibility when working with members of the research team. Third, consultants must have an understanding of grant proposal preparation and the submission process and other aspects of research data management: creation, processing, analysis, preservation, access, and re-use. In addition to the above staff skills and knowledge areas, consultants are also expected to display initiative, confidence, and trust. The university has sought new staff to take on the role of consultants and sent existing staff to workshops and other professional development opportunities to foster these skills internally.

To complement the technical skills that the consultants must possess, the university and library have invested heavily in high-performance computing centers, specialized hardware and software to aid computational and collaborative science, storage management systems to handle the large amounts of data being generated, and a usable search and retrieve interface for locating pre-existing data. The library has also embraced the notion of data as a new type of collection. Money is invested in the purchase of any datasets that are requested.

**Implementation facilitators and barriers.** The data consulting group has been successful and continues to expand its programs and services. There were no identifiable barriers. The NSF data management plan requirement was an important facilitator of the growth

of the group and contributed to recognition from across the institution that the library is the locus of expertise in this area.

### **Changes Occurring to Implement E-Science Programs and Services**

The library is in a constant state of change. Each year strategic priorities are set and library staff are shifted to where they are most needed and asked to take on tasks that are critical at that point in time or need to be further explored. One example is the digital library group that was initially formed in 2002 without any plan for long-term sustainability. Over the past decade the library reallocated resources from more traditional kinds of library activities to this one. The department has grown from four to twelve people, and in all this time has only requested outside funding for one new position. Seven of the people who currently work in that unit were reassigned from other library divisions. Library administration admits that it cannot do everything and that it must choose centers of excellence; and focus on doing things the library is good at and no one else is doing. That has been a dramatic change that has to do not just with the organization but also with the way in which the library allocates funds.

A second example of change is the formation of the data consulting group that was established in October 2011 as a cost-recovery unit. The formation of this group has been important for the library because it has brought library staff in direct consultation with researchers, as part of the research team, in a way that did not exist before. According to the librarians in the group, the researchers recognized the level of customized services offered. The librarians reported that researchers reviewing the data management plans that were developed to date were impressed because the plans were clearly not boilerplate, “pulled down and crammed in,” but really thought-through customized plans. According to the director of this group, being

able to show this kind of direct utility so quickly is new for the library and has been the single most important thing the consulting group has done.

These two new service units for the library have resulted in new roles for library staff. They are asked to move away from a traditional print and collection focus to a services focus, and to reach out to new faculty and researchers to partner on work that is occurring outside of the library and earlier in the research cycle. The library has created new positions and hired new staff to facilitate this change.

**Future changes.** The library administration sees more changes ahead, stating “We cannot be calcified in one area of research methods when the opportunities for research are changing so dramatically. We really cannot continue to be stuck in our old ways of looking at what service means.” One area of new focus is GIS, as more faculty are asking the library for help incorporating GIS into their teaching. The library is planning to create a new instruction classroom, and to incorporate these requests and other requests for data-based instructional programing into future library redesigns.

Within the university environment, the library expects a number of new university initiatives to emerge that will influence future interests and priorities of researchers. In addition, the library is anticipating changes in national politics and funding mandates that will focus on data management. The library plans to monitor these changes through a continual environmental scan. The planned response is to expand library capabilities and funding in areas that are identified from year to year.

**Experience of change.** The librarians work in a new environment. What they are experiencing is different from traditional library services. The new work is seen as being different from other digitally-oriented library services such as digital repositories for documents

or faculty publications. Data management and planning are distinctive in a number of ways. Some of the functions are similar (organization and cataloging) but data management is seen as a function different from traditional librarianship; to be engaged in it librarians need to leave the library and work with the research team.

One key change is the emphasis on service over content. The focus on data management is more about service provision with the goal that content will start to be collected – similar to a new special collection for the university. The amount of data the library stores is expected to grow over time. For those promoting the library's involvement in e-science and data management, the acknowledged change in roles and responsibilities has been welcomed, and there is a strong sense that more needs to be and can be done.

**Type of change.** The library administrators categorized the change as evolutionary; gradual, but steady; they are taking the long view. For those working in the digital library service group and the data consulting group there was a sense of change being both evolutionary and revolutionary, the latter in the sense that it is a new area and they were trying to figure out how to do all this because there are pressures to do it quickly and to do it well. Working with data was perceived as a radically different view of what libraries do, even though data management activities are at the early stages of development. However, there was acknowledgement that work had been done in these areas without realizing it, including early work in digitizing collections and a review and analysis of repositories, platforms, and technologies. All of this was done in the decade preceding this dissertation research.

### **Role of Administration**

Library administrators identified two roles. One is to highlight the importance of data management and to tie it back to the library's mission. This is accomplished by participating in

and influencing the dialogue and conversations that are taking place throughout the university, and representing the library and the role it can play. The other is to show that the library is committed to furthering research in library and information science and being viewed as a research unit equivalent to any other university center. The library, which is viewed as a partner and a leader, is seen as a valuable resource in contributing to the development of data management services across the institution. The library has been recognized for the unique skills library staff offer the institution's researchers.

**Leadership challenges.** The challenges that the library administration has faced involve raising awareness, educating faculty, and developing the appropriate staff expertise. Due to the low turnover rate among staff it has been a challenge to work with human resources to add new responsibilities to existing job descriptions and to encourage staff to assume new roles. Additionally, as one of the first institutions to become involved in data management, administration and librarians have had to deal with a large amount of trial and error, and discover and set best practices. Doing this without a set of peers to consult has been a challenge.

**Communication.** The administration relies on internal and external methods to communicate the need for librarians and staff to assume new roles. Internally it used Web-based tools and social media. The library maintains a wiki, blog, and Twitter feed. The library administration also relies on peer-to-peer communication among librarians to promote new knowledge, skills, and abilities, as well as the new services under development. Librarians are encouraged to write for professional publications and attend and present at conferences related to data management.

**Empowering staff.** Librarians who are actively moving in the new direction set by the library administration are rewarded and recognized. These librarians are given a broad

framework within which to work and explore new roles. They are also given special assignments and held up as an example to others. Staff are also empowered by having set goals and rigorous evaluation plans in place to measure success.

**Sustainability.** The primary method used to sustain the enthusiasm for change has been to hire staff who are interested in and dedicated to these new opportunities. It is critical that library goals and priorities remain aligned with institutional goals in order to ensure long-term partnerships with faculty. The library is relying on grant funds to sustain the data consulting group. That group in turn relies on peers from other libraries to help develop the tools and resources needed to build and advance data archiving and retrieval technology.

**Hurdles to implementation.** One important hurdle for library administration is to change the current culture in the library. The culture is described as being very passive. Some of the staff are not interested in taking on new duties or learning new skills. This, coupled with a lack of turnover and resistance from human resources to think of the library job descriptions in a new way, partially accounts for the slow, evolutionary change that is happening.

In addition to the resistance to change among some staff, the library administration has had to deal with limited resources and competing priorities. The library budget has been stable but is unable to keep pace with the cost of resources and the desire to expand services. Library administration reviews priorities on an annual basis and adjusts staffing and funding accordingly.

### **Summary of University D**

Table 3.6 summarizes the unique attributes of University D as discussed above.

Table 3.6

*Unique Attributes of University D*

Category	Unique
Future changes	Monitor national politics New facilities Obtain additional funding New administrative issues
Experience of change	Focus on services not content
Library/librarians Role	Data archiving
Skills	Initiative
Role of library administration	Participate and influence dialog at the university level Represent the library at the university level and promote the library as research partner Highlight the importance of research partnerships and tie it to the library mission
Leadership challenges	Encouraging staff to take on a new role Adding new responsibilities Lack of peers
Method used by administration to empower	Increase in responsibility Establish a broad framework
Sustainability	Distributing best practices Aligning with institutional goals
Leadership hurdles to overcome	Explaining to HR Passive culture

**Conclusion**

Throughout the site visits the investigator noticed that the participants felt that, although they had been working on e-science and data management issues for a number of years, there was still much work to be done. The library is seen as a critical partner in helping these institutions move forward. The leadership provided by the library director is viewed as one of the vital elements in the library's inclusion in e-science across campus.

The four libraries exhibited a number of similarities in their organizational responses to assuming the new role of data management. These included creating a new specialized unit or team to develop and provide services to faculty, supporting the continuing education of existing staff who want to learn more about data management, and hiring new staff with specialized knowledge, skills, and abilities. In all the cases there was a pervading sense that carving out a role for the library was critical to the future of library services. Although the library director heavily influenced the experience of change and how the institution viewed the library, there was a strong feeling that the libraries (and all university research libraries) were slowly and methodically moving in this similar direction.

The next chapter presents the general findings applicable to two or more of the four cases. It relates these findings more explicitly to the role of the library at the institution from the perspective of the library and university administration, and demonstrates how library administration has brought about the necessary changes to transition into this new role. The chapter also explores the cross-case findings to reflect on themes and patterns of similarity and dissimilarity that have emerged.

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## **Chapter 4**

### **OVERVIEW OF THE CROSS-CASE FINDINGS**

This chapter presents an overview of the broad themes and similarities that emerged from the results of the four case studies, but does not include the investigator's interpretation of the meaning of these results. Interpretation and discussion occur in subsequent chapters, followed by the concluding chapter, which analyzes the general themes and implications of the study, and presents topics for further investigation.

Data from the four case studies demonstrate that there are more similarities than differences when it comes to research universities and their libraries becoming engaged in e-science, including the structural and programmatic changes that have occurred in libraries to provide e-science services and programs, and the leadership necessary to bring about those changes. The following discussion focuses on the library's role in this process as identified by two or more of the four sites visited. The investigator was unable to collect a sufficient amount of data at the institutional level to comment on similarities of how e-science is conceived and implemented at the institutional level, with one exception. Institutions A and C both identified the same three critical partners in implementing e-science programs and services across the institution: the office of research, the office of information technology, and the library.

#### **Library-Based E-Science Services and Programs**

Gold (2010) identified four areas for library involvement in e-science services: education, policy, research, and services. All four sites in the study have been active in each of these areas, with more overlap than uniqueness among the sites. This chapter discusses the roles of library

along with the most common delivery methods used to deliver services, and implementation barriers and facilitators to moving into these new roles.

## **Education**

The educational role the library has assumed has taken two paths. The first focuses on training faculty, students, and researchers (sites A, B, C, and D); the second focuses on training librarians (sites A, B, and C). Librarians at all four sites have developed and offer weekly or monthly workshops related to data management for researchers; however, much of the education for researchers has occurred face-to-face on an as-needed basis. Three of the sites (A, B, and C) have also assumed a role in developing and providing workshops not only for their own librarians to help them feel comfortable talking with researchers, but also for librarians outside of their institution to begin to build a network of peer support and to learn from one another. In these instances, the focus has been to bring in outside speakers to talk about the importance of libraries supporting e-science, and what that means for the local library and for the future of the library profession. Libraries at sites A, B, and C have also made contact with library and information science (LIS) master's programs to exchange ideas as to how to incorporate more data management techniques and discussion of related issues into the curriculum. One result of these discussions at libraries A and C has been to support data management internships (typically one semester long) for students who are interested in working in this area, believing this type of opportunity to work with data as students will encourage LIS graduates to seek employment and further their education in the area of data management. Table 4.1 summarizes the common roles in education.

Table 4.1

*Role in Education*

<b>Role</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Continuing education for librarians	X	X	X	
Developing workshops for faculty, students, researchers	X	X	X	X
Supporting data management internships	X		X	

**Policy**

All four libraries (sites A, B, C, and D) have had a formal role in setting university-wide policy by serving on campus-wide committees that discussed issues related to data management. They have contributed and shared information and have the opportunity to interact and provide feedback, and express suggestions and concerns. Libraries at sites A, C, and D have partnered with researchers specifically to manage the external data requirements imposed by funders. Three of the four libraries (sites A, B, and D) have played an active role in helping to set national metadata standards; all four indicated that they advised researchers on options or proposed existing standards that could be implemented on specific projects. Table 4.2 lists common policy-related roles.

Table 4.2

*Role in Policy*

<b>Policy</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Advising on policy and procedures	X	X	X	X
Setting metadata standards	X	X		X
Partnering/managing external data compliance	X		X	X

## Research

Two main roles related to research were identified in all four libraries (sites A, B, C, and D): partnering with researchers to secure external funding and writing grants. Details were not given as to the success rate in these endeavors, or to the specific types of grants applied for, or what the assigned roles of the grants were (if funded). However, more details on the types of services provided are listed in the next section.

## Services

In relation to the list of 14 services related to e-science provided by the libraries (Table 4.3), all four libraries provided eight of the services. These core services included traditional reference and consultation services, but with a focus on data: how to manage, store, and ensure long-term preservation and access. Offering assistance in designing data management plans has been the one service that has led to opportunities for libraries to highlight the importance of sharing data, promote services the library offers through the institutional repository, and explain it is appropriate to store data there. Libraries have been able to plant ideas for future partnership when data management is considered and implemented throughout the course of a research project.

Table 4.3

### *Common E-Science Services Provided*

Services	Site			
	A	B	C	D
Applying metadata standards	X	X	X	X
Building institutional repositories (bibliographic and data)	X	X	X	X
Creating digital object identifiers (DOIs) for future referencing	X	X	X	X
Creating permanent URLs	X	X	X	

Table 4.3 (*continued*)*Common E-Science Services Provided*

<b>Services</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Data management planning	X	X	X	X
Developing/modifying controlled vocabularies/content standards	X		X	
Dissemination and discovery of datasets	X	X	X	X
Documenting rights management	X	X	X	
Facilitating dataset retrieval	X	X	X	X
Participating as a member of the research team	X		X	X
Promoting the sharing and reuse of data	X	X	X	X
Providing reference and consultation services	X	X	X	X

A number of services relate to facilitating the dissemination and discovery of datasets. First, university administration and research faculty view librarians as the local expert on metadata standards. Librarians consult on projects in a wide range of subjects, often working with researchers to determine which data elements are critical to the project and to identify the key elements that future researchers will be interested in using as discovery points. Two libraries (sites A and C) create controlled vocabularies for local projects. Second, all four libraries create DOIs for datasets. Libraries (sites A, B, and C) are also involved in documenting data usage rights and creating permanent URLs for datasets. Sites A, B, and D indicated that new e-science programs and services provided opportunities for librarians to become embedded in and to be active members of research teams in which they manage research data and offer other information-related services such as literature searches, bibliographic management, and other contributions to the overall work of the project.

## Delivery

The four libraries use two different approaches to offering services for researchers: (1) a special section of the library website dedicated to the topic, and (2) customized workshops as described above, in which researchers can learn about data management requirements specific to their areas of study and funders. These two methods, in addition to reaching researchers through a liaison role<sup>1</sup> (sites B and C), offer flexibility by providing just-in-time/on-demand services.

Additionally, libraries at sites A, B, and D conducted an internal assessment of researcher needs and how these lined up with the current library services, and then decided to form new departments to bring like staff together and add formal authority and recognition to the services being offered. These same libraries have also actively sought opportunities to partner with researchers on grants and provide data management services as part of the research team. Table 4.4 lists the common delivery methods used.

Table 4.4

### *Methods Used to Deliver Services*

Delivery Method	Site			
	A	B	C	D
Liaison model		X	X	
Partnering on grants	X		X	X
Assigned to a specific department	X		X	X
Website	X	X	X	X
Workshops	X	X	X	X

<sup>1</sup> The liaison role is characterized by Rodwell and Linden Fairbairn (2008) as an outward-looking service, emphasizing stronger involvement and partnership with the faculty and direct engagement in the university's teaching and research programs.

## **Implementation Facilitators and Barriers**

Facilitators and barriers to implementation were solicited from librarians who provide e-science support services. Two facilitators were identified by two or more libraries; librarians at sites A, B, and C recognized individual initiative as an important contributor to their success, indicating that it took a concerted effort to educate themselves and translate the knowledge gained into an action plan to reach out to faculty and form new partnerships. Associated with this is the other common facilitator shared by librarians at sites A, C, and D: the NSF data management plan requirement.<sup>2</sup> As a result of this new policy, librarians saw an opportunity to identify what NSF was looking for in a data management plan and then talk with researchers and share their expertise. Only one barrier, limited resources, was shared by three libraries (sites A, B, and C). The resources specifically identified referred to staff, and particularly funding to hire additional qualified staff.

## **Changes Occurring to Provide E-Science Services and Programs**

Of the 10 shared changes identified, all four libraries experienced at least five of them (see Table 4.5), which allowed the investigator to detect a common process used in the four libraries to bring about change. There was an identified need for data management support and education on campus, and the library administration believed it was essential for the library to establish itself as a principal contributor, offering unique skills that could be applied to meet this need: organization, classification and subject indexing, authority control, and metadata. Initially one or two librarians were asked to take the lead in developing some new data-related services. These librarians at first saw this task as an added responsibility, but then realized it was really more than a new service; it was a new role that they were assuming. They were soon

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<sup>2</sup> Effective January 18, 2011, all proposals submitted to NSF must include a supplementary document of no more than two pages labeled "Data Management Plan" (DMP). The supplementary document must describe how the proposal will conform to NSF policy on the dissemination and sharing of research results.



working with new groups across campus and building new partnerships. As the demand grew, the library administration formed a new department and redesigned positions and recruited staff to meet demand.<sup>3</sup>

Table 4.5

*Types of Change*

Change	Site			
	A	B	C	D
Embedded	X		X	
New department	X	X	X	X
New knowledge, skills, and abilities	X	X	X	
New library role		X		X
New positions	X	X	X	X
New services	X	X	X	X
New structure	X	X	X	
Reach new groups	X	X	X	X
Role change / added responsibility	X	X	X	X
Workflow	X		X	

Three of the four libraries (sites A, B, and C) indicated that the creation of the new department resulted in a larger restructuring of the library. This restructuring included new reporting lines and hiring new staff and/or managers. During interviews at these same three libraries, librarians and administrators discussed the need to acquire new knowledge, skills, and abilities to meet the demands of providing data management services; hiring new staff was seen as the primary way to fulfill the need for a new type of expertise.

Libraries at sites A and C shared two common changes. The first change was to become actively embedded in departments outside of the library. This is primarily done by partnering on grants. The second change was the impact of data management on internal library workflows. As specific departments and individual librarians become knowledgeable about NSF data

<sup>3</sup> Chapter 6 covers the change process in greater detail.

requirements, metadata, and subject repositories, questions arose as to how to handle inquiries for data services; should everyone be able to answer questions and provide services, or should inquiry be funneled to a designated library department or individual?

Libraries at sites B and D were the only two to indicate that supporting e-science and data management was a new role for librarians. The traditional independent and entrepreneurial nature of researchers at these two universities resulted in a decentralization of many networking and related technical infrastructure services; however, researchers look to the library for its expertise in long-term preservation, access, and metadata. As new relationships formed, librarians found themselves in a new role.

### **Future Changes**

Although all the libraries in the study have established programs and services to support e-science and specifically data management, they indicated more work still needs to be done and additional changes were to come. Libraries at sites B and D specified that additional resources and effort would be put towards monitoring the environment, both at the university level and in how research is being conducted, so that they may continue to modify existing services and plan for new services. They also specified that they would continue to monitor what was happening at other peer libraries and how e-science affects the library profession.

At the time the investigator conducted interviews, libraries at sites C and D, had not made major changes to librarians' job descriptions. New descriptions were written for newly created positions, but no substantial re-writing of current positions had been undertaken. E-science related goals were set annually and discussed; there remains a specified need to formalize duties such as data management and partnering on research grants into new positions, and also to go back and incorporate those duties into existing job descriptions.

## Experience of Change

Despite the differences in local culture and among individual librarians, there is some overlap in the experiences of changes that have occurred (see Table 4.6 for a summary of the changes). Librarians at institutions C and D considered the many changes they experience and indicated that they believed librarianship was moving into a new area or environment; one that focuses less on the historical print collection and considers raw data to be an important asset. They believe that they have the foundation and the skills necessary to take an active role in this new environment, one where the emphasis is more on services than on collections.

Table 4.6

### *Librarians Experience of Change*

Experience of Change	Site			
	A	B	C	D
New area			X	X
New attitude/view	X		X	
Opportunity to form new relationship		X	X	
Outside / researcher resistance	X		X	
Requires self-education	X		X	

Agreeing with the above statements, but experiencing the changes as an internal rather than external reaction, librarians at sites A and C stated that in order to manage change it was necessary to adopt a new attitude or view of the library's role and purpose within the institution; librarians are embracing the opportunity and welcoming the changes that e-science has brought about. Librarians at both institutions emphasized the importance of self-education. They indicated that there was support from library administration for additional training, but still felt it was their personal responsibility to participate in the training being offered and to acquire any secondary subject knowledge required.

Librarians at sites B and D shared a common experience of reaching out to new groups while providing e-science services. One group on campus specified was those working in administrative positions within research departments, but new researchers and faculty were also mentioned. By contrast, librarians at institutions A and C indicated that researcher resistance was a hurdle that they had to overcome; they had to do a more effective job at communicating the benefits of including librarians early in the research process.

### **Type of Change**

Library administrators and librarians were asked two questions regarding the types of changes occurring in the library. First, they were requested to categorize the changes that have been taking place as either evolutionary (small and methodical) or transformative (major and revolutionary). Second, they were asked if the changes were primarily in content (type of materials, skills used) or in context (environment, role) (see Table 4.7).

Table 4.7

#### *Type of Change: Evolutionary or Transformational*

<b>Type of Change</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Blend (evolutionary and transformative)		D, L (3)	L	L
Evolutionary	D, A, L (2)	A, L	D, A, L (5)	D, A

Key: A = Associate Director; D = Director; L= Librarian

The question of whether the changes were evolutionary or transformative in nature sparked much discussion. Although no one interviewed believed the changes to be out-right transformative, librarians at three locations (B, C, and D) indicated there was an element of the transformativeness present, stating such things as:

- “the ideas are a revolutionary way to think of librarianship” (Focus Group Participant at site C),
- “if we had more time to dedicate to the projects it could be revolutionary” (Focus Group Participant at site B),
- “part of the constraints on how transformational it is for us is the resource constraints that we are under” (Focus Group Participant at site B),
- “I think for the library at large, it is revolutionary. I would share that my manager looks at it and says this is the future of libraries. It is quite revolutionary. It really shakes the fundamentals of what libraries do but we are just at the early stages of it. But it has great potential” (Focus Group Participant at site C).

Sentiments such as these lead to two other shared themes. First, comments such as “rapid little steps” (Focus Group Participant at site A) or “hurry up and wait” (Focus Group Participant at site C) were shared, implying that the changes were evolutionary, but at times felt revolutionary; as if they were being taken in a whole new direction and required to learn new skills. A second theme common to these two libraries (sites A and C) is that the library was reacting to external forces, stating that the truly transformational changes were occurring outside of the library. Examples mentioned included how scientific research is being conducted and the emphasis on collaboration and interdisciplinary research.

The associate directors were consistent across the four libraries in declaring that the change was evolutionary in nature: three of the directors (at sites A, C, and D) agreed with them, testifying that it took time to communicate how e-science and data management fit with the overall vision of the library. Administration was slowly setting goals that would gradually bring about the changes. The directors wanted to make sure the staff were in place and were trained

and ready for the new role, and that there were opportunities for early successes. Other reasons given for the evolutionary pace of change were: all changes are carefully planned and processed, applying the resources took time, there was a period of experimentation, and success had been limited.

Regarding whether librarians view the recent changes as changes in context or content, there was no clear answer (see Table 4.8). Eight librarians indicated that the change was in context (environment and role). In their opinion the content was the same; however, librarians were now getting involved earlier in the research process and data life cycle, forming new relationships, and placing a greater emphasis on services: “It certainly is the context because we’ve traditionally been in the point of helping the faculty member find supplementary information to help them with their current research. Here we are helping them conduct their real research as opposed to the literature review or looking up things that they might use” (Focus Group Participant site C). However, five librarians (at site A, B, and C) did not see the distinction so clearly:

I would say when you start doing it; it feels like a whole new area. It’s not something that you can just walk in and instantly feel comfortable with. There is a large learning curve to be able to adequately understand even what you are talking about. ... There was a lot of self-education that had to happen there. Once you are in it, I see a lot of parallels with what I am already doing.

I think it depends on how far you are into it whether that is the case or not.

(Focus Group Participant at site C)

Further,

The content is a different kind of content and yet the content is so different that the context is different too. I am still using a lot of the same skills that I always had, analyze, breakdown, facilitate. I don't think that taking a dataset and moving it through the process of getting it absorbed by the library, for example, is really anything like what we've done before because there is something so inherently different about the content. We have to change how we do that because it just doesn't make sense anymore. (Focus Group Participant at site B)

Table 4.8

*Type of Change: Content or Context*

Type of Change	Site			
	A	B	C	D
Content		L		
Context	L	L	L (4)	L (2)
Blend (content and context)	L (2)	L (2)	L	

### **Role of Library Administration**

The role of library administration varies from institution to institution based on local culture and needs; however, two of the libraries, sites B and C, shared three common roles. The first is to create buy-in and make sure all staff are pointed in the same direction. This involves demonstrating how e-science and data management align with a library's overall mission and vision, and indicating how current and new staff will fit into this new future. The second is to provide a workflow so that the library staff can move quickly and decisively when opportunities arise. The third is to oversee the lasting development and sustainability of programs and services,

hoping to ensure the programs and services will remain viable in the long term; meaning it is the role of administration in these instances to make sure library staff have all the appropriate resources as librarians focus on building new relationships and learning about the data to be managed.

### **Setting Vision**

A primary function of leaders is to produce change and set the direction of that change. Setting the direction is not the same as planning. Planning is a management function designed to produce results, not long-term transformational change. Setting the direction is inductive; leaders look for patterns, relationships, and linkages (Kotter, 2008b). The end result is vision. According to Freed and Klugman (1997) “A vision statement is a philosophy about values; it is futuristic and optimistic ... [It] answers the question: Where do we want to be in five to 10 years and what do we want to be doing?” (p. 59).

Seeley (1992) defines two types of vision, both related to the concepts of first- and second-order changes as proposed by Levy and Merry (1986). Using the concept of first-order changes, those that deal with functional improvements, Seeley asserts that these changes are connected to first-order vision or program vision. An example of a change requiring a program vision in this study is the introduction of e-science programs and services.

Second-order changes are those that necessitate a restructuring or a re-thinking of an organization's roles, rules, relationships, and responsibilities. Seeley (1992) stresses that such second-order changes require system vision. "The leader has to visualize not just how a new program or practice would work, but how whole new sets of expectations, relationships, accountability structures, etc., would fit together into a coherent whole" (Seeley, 1992; Section 2:



System Change Requires System Vision). Libraries at sites A, B, and C have both a program and system vision.

The program visions at sites A, B, and C share the common themes of serving the local communities, increasing researchers' data awareness, and providing data management educational programs. (The systems visions at these same sites are unique to the local environment.) In addition, the library administrators at the three sites (A, B, and C) all commented that the program vision was a shared vision<sup>4</sup> and was conceived with input from library managers and key librarians, as well as input from external partners such as strategic partners, the office of information technology, and the office of research.

### **Leadership Challenges**

All leaders encounter challenges, issues, and difficulties every day. As roles and responsibilities change, this brings tribulation, and no matter how good a leader someone is, he/she cannot stop that from happening. How the leader handles those ordeals will define him or her as a leader and have a great deal to do with how effective the leader is (Kotter, 2008b). Every leader must face challenges and learn to deal with them in some way.

Five identified leadership challenges were shared by two or more of the four libraries (see Table 4.9). The one challenge shared by all four libraries is the need for staff with the appropriate knowledge, skills, and abilities to assume new roles of data manager and researcher partner. This lack of staff capacity, the need for focused expertise, and the desire for freshness and objectivity resulted in library administration seeking to recruit new staff who could provide an infusion of energy and be in a position to seize opportunities more quickly.

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<sup>4</sup> The concept of shared vision is developed in more detail in Chapter 8.

Table 4.9

*Leadership Challenges as Identified by Library Administration*

<b>Leadership Challenges</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Data needs vary among disciplines	X	X		
Educating faculty	X			X
Identifying library role	X	X		
Raising awareness	X	X		X
Staff knowledge, skills and abilities	X	X	X	X

The second most frequently identified challenge (libraries at sites A, B, and D) is raising awareness within the library and across the institution. Lack of awareness of why a change is being made can be the primary reason for resistance to the change. Without current information on pending changes, it becomes a challenge for an individual to align with the direction of the institution. Internal communication is essential in dealing with this challenge; it involves frequent, detailed, timely, and relevant communications that address what is changing, why change is being made, and the rewards and risks of not changing as a library and on an individual level. All of the libraries studied have engaged specific staff in e-science project planning and visioning from the outset and identified them as “change agents” (someone helping to push the boundaries of what the library can do differently) to be on-going champions of change within the library and across the institution. Libraries at sites A and D specifically mentioned the challenge of educating faculty about the importance of data management and the support that the library is able to offer. Still, the majority of faculty view the library as a repository of books.

Another challenge that two libraries (sites A and B) face is that each discipline has its own particular requirements and issues associated with data management. There are highly independent departments that want to take a decentralized approach, and those that seek

centralized support programs. There is tension between the two groups, and it has been difficult for the library staff to bring together those disparate perspectives, and to communicate that everyone is working toward the same end. The library seeks to be respectful and supportive of the different approaches and data needs of various researchers.

Libraries at sites A and B also shared a second common challenge, that of identifying the role of the library in data management. There is a strong tradition of researcher independence and control over how they conduct their own research and how they manage the data they generate; it has taken the library a long time to identify and work through all the issues and reach a common level of agreement about who should be doing what. These discussions are not just limited to faculty and researchers; other support services such as information services and the office of research have also been included in these types of discussions.

## **Communication**

Communication is an important part of change management. One aspect of success in managing organizational change is the ability to choose the right channels of communication that match the context and to phrase the messages properly (Kotter, 1990). Although no one method of communication was shared across all libraries, administrators are using a variety of channels to relay the importance of the library becoming involved in e-science and data management (see Table 4.10).

There were two popular methods for communicating the importance of change. The first is meetings and presentations for all library staff (libraries at sites A, B, and C). This type of communication was seen as a way for library administration to present formally the plan and strategic priorities for engaging in e-science and to begin a dialog about the impact of change. The second method used to communicate the importance of the pending changes was to make

structural adjustments to the organization and reporting structures (libraries at site B, C, and D).

Administrators thought the most effective way to communicate importance was to reassign staff and assign resources to the formal e-science and data management programs.

Table 4.10

*Communication Methods Used by Library Administration*

<b>Method</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
All staff meetings/presentations	X	X	X	
Campus committees	X			X
Discussion and visualization with staff		X	X	
External publications (professional literature, conferences, social media, website)		X		X
Internal publications (staff wiki, e-mail)		X		X
Structural changes		X	X	X

## **Empowering**

Empowerment occurs when organizational leaders engage staff in ways that promote personal and professional growth. Leaders help employees to extend their capabilities and thus make progress toward realizing the staff's full potential (Erickson, Hamilton, Jones, & Ditomassi, 2003). Administrators at all four libraries see providing encouragement to librarians as an important factor in empowering them to change. One specific type of program identified to do this is a formal rewards and recognition program. As well, library administrators at sites B, C, and D feel that giving librarians the freedom to explore new relationships and roles is a critical step for librarians becoming comfortable in assuming new responsibilities.

Believing everyone in the library has something to contribute to the development of the vision, library administration at sites B and C actively encourage librarians to take risks and propose innovative ideas and programs. Knowing that the library was moving into new territory,

and there were no reference points to judge whether ideas were good or bad, useful or useless, library administrators listened to all ideas and worked in small groups to cultivate the best ideas and encourage ownership of the emerging initiatives. Table 4.11 summarizes the methods library administrators used to empower staff.

Table 4.11

*Methods Used by Library Administration to Empower Staff*

Method	Site			
	A	B	C	D
Give staff the latitude to explore		X	X	X
Encourage innovation		X	X	
Provide encouragement	X	X	X	X

## Sustainability

Sustainability requires widespread operational and cultural changes. Library administrators have taken a number of operational steps to help ensure sustainability over time (see Table 4.12). The first action taken at the libraries at sites B, C, and D was that their administrators prepared library staff to assume new roles through training and/or mentoring programs. Beyond ensuring that existing staff understood the importance of moving in a new direction by assisting researchers with data management, administrators at three libraries (at sites A, B, and D) obtained the funding necessary to provide needed resources, one of which was the funds to hire new staff. Library managers indicated one of their major challenges was creating staff expertise. A critical step in sustaining the desired changes has been to bring in new staff with the needed skills and drive to ensure the library continues to move forward in bringing about the desired future. Finally, to help internalize the changes and make them part of the new culture going forward, libraries at sites A, B, and D have incorporated the changes into the

reporting and evaluation process. This is an important step in internalizing the libraries' new role.

Table 4.12

*Methods Used by Library Administration to Sustain Changes*

<b>Method</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Assume new roles		X	X	X
Hire new staff with skills and interest	X		X	X
Incorporate into reporting and evaluation structure	X	X		X
Obtain necessary funding	X		X	X

### Hurdles to Implementation

Implementing a major change is complicated. Managerial leaders must address not only individual barriers to change, but also the organizational dynamics that often thwart these efforts. All four library directors identified to hurdles as limited resources: staff, money, and time (see Table 4.13). Associated with this, administrators at sites C and D indicated that there were many competing priorities coupled with limited resources, which make it difficult to meet all the institutions needs associated with providing comprehensive data management services.

Table 4.13

*Hurdles to Implementation as Identified by Library Administration*

<b>Hurdles</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Competing priorities			X	X
Limited resources	X	X	X	X
Staff resistance		X	X	X

A final hurdle identified by administrators (sites B, C, and D) is staff resistance to the changes and to assuming new roles. Director D summarized the issue: “Staff are creatures of habit and find it hard to abandon behavioral routines that the organization considers no longer appropriate. They like comfort zones by continuing routine role patterns.” People resist structural and cultural changes that force them out of comfort zones and require investing more time and energy learning new role patterns.

### Conclusion

As Table 4.14 shows, the greatest area of similarity among the four sites is in the services the library provides and the changes that have been brought about in order to provide those services. There are fewer areas of overlap in the roles the library assumes on campus in support of e-science, such as participating in the establishment of policies and assuming a role in research.

Table 4.14

#### *Summary of Site Commonalities*

Category	Similarity
Role in supporting e-science	Developing workshops for faculty, students, researchers
Role in policy	Advising on policy and procedures
Role in research	Partnering with researcher to secure funding Writing grants
Services provided	Applying metadata standards Building institutional repositories (bibliographic and data) Creating digital object identifiers for future referencing Data management planning Dissemination and discovery of datasets Facilitating dataset retrieval Providing reference and consultation services
Delivery Method of services	Website Workshops

Table 4.14 (*continued*)

*Summary of Site Commonalities*

<b>Category</b>	<b>Similarity</b>
Changes occurring	New department New positions New services Reach new groups
	Role change / added responsibility
Leadership challenges	Staff knowledge, skills and abilities
Method used by administration to empower	Provide encouragement
Leadership hurdles to overcome	Limited resources

Overall, the majority of librarians and administrators interviewed agreed that the changes that were occurring were coming about slowly and methodically and that the change was primarily one in context (the environment). When it came to leadership issues such as challenges, methods used to empower librarians, and hurdles to overcome, there were some identified core issues, but overall there were limited similarities, perhaps due to local culture and leadership styles.

There were five areas in which two or three libraries shared similarities:

1. Implementation facilitators and barriers;
2. Future changes;
3. The librarians experience of change;
4. Methods of communication; and
5. How changes are sustained.



Again, many of these areas are more closely related to internal factors in which the library operates, such as the library's relationship with university administration, the skill set and learning curve of the librarians, and the resources with which the library has to work.

Findings from the individual case studies and the cross-case themes described in this chapter are discussed and interpreted in the following chapters. The first of these chapters, Chapter 5, examines the driving forces for change. Chapter 6 discusses the stages and process of change, while Chapter 7 reviews what changed and the nature of those changes. Chapter 8 addresses the leadership issues associated with bringing about those changes. Chapter 9 draws together the important themes covered in this and the previous chapter, and reflects on the implications of the study's findings for academic libraries, as well as identifying topics for further study.

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## **CHAPTER 5**

### **THE DRIVING FORCES FOR CHANGE**

There are numerous drivers of organizational change. In some instances change can be a response to natural growth and success, or to a crisis. Some internal changes can also be considered necessary adjustments in order to maintain the status quo, not necessarily to transform an organization. Not all change is of the same magnitude. Some changes have greater implications than others for staff members and other stakeholders who are experiencing the changes (House, 2005; Wagner, 2006).

A variety of labels are given to the differing types of change, such as technical versus adaptive challenges (Heifetz & Linsky, 2002) or episodic versus continuous (Weick & Quinn, 1999). As outlined in Chapter 2, this study uses the concept “first-order” and “second-order” as established by Levy and Merry (1986) to distinguish the type of change occurring. (Table 2.2 presents the differences between these orders of change.) As a first step in understanding the order of change, the investigator applied Lundberg’s (1984) forces for transformational change (enabling, permitting, pre-existing conditions, and triggering events), which serves as the framework for this discussion about why the libraries under study became involved in e-science.

Before examining the forces that propelled a library to become involved in e-science, it is important to consider what library administrators said when asked why it was important to be involved in e-science activities on campus. In all four libraries the investigator was told that the library staff had skills and expertise, pre-existing relationships, and direct experiences that could be applied, and that supporting researchers' information needs is a critical part of the library’s

mission (see Table 5.1). These themes emerge repeatedly through the chapter as the driving forces for change are examined.

Table 5.1

*Why it was Important for the Library to Become Involved in E-Science*

Why	Site
Well, libraries are all about content. Data underlies the content that makes up the published scholarly record. So, I think, for me it is a very obvious conclusion that libraries need to be involved in managing the underlying data or at least in making the connections with the organizations that will help to manage the underlying data that supports research across different subject domains. And also developing and insuring that best practices are used in order to manage and curate that data and insuring that there is a final or ongoing way in which these data can be maintained. You know, I see that as one of the three pillars of librarianship with the responsibility just extended to focus on data because essentially it is what underlies the content of published literature. (Associate Director)	A
It seemed appropriate and natural to us since we support research here to follow and in some cases try to anticipate where research was headed in terms of use of digital objects and digital tools and digital manipulation and data mining and so on and to support them in these new media as we had supported them before. ... This is just the way that scholars and researchers work these days. It seemed entirely appropriate to us that the libraries should track with them into this brave new world. (Director)	B
The libraries have a lot to offer, in terms of expertise around issues associated with managing data, if you think about the life cycle management of it and in terms of providing access to it and about preserving it for the longer term. These are important issues that are really going to be, if anything more important, going forward, as research becomes even more data intensive and more and more data is created and as mandates for sharing the data increase as well. All universities are going to have to, or all research institutions are going to have to deal with how to develop best practices and with data life cycle management and because the libraries have long experience and expertise, in terms of preservation of information, applying metadata for discovery and access, and rights management and things. I think there are roles and value that we can provide. And working with others in our context here at the university, in terms of coming up with the right set of solutions and approaches and developing the roles and responsibilities in a manner that will move us all forward. (Associate Director)	

Table 5.2 (*continued*)*Why it was Important for the Library to Become Involved in E-Science*

<b>Why</b>	<b>Site</b>
Someone has to do it and we are the ones that have the intellectual and theoretical knowledge to organize and allocate identifiers to data. You have to think of data as being analogous to collections. (Director)	C
It's really important to help scientists and researchers manage their data which of course, includes the preservation and curation so that they can focus more on their science. I think the library is an organization that can do that. I think the library is an organization that thinks about the long-term, focuses on preservation, has a sustainable source of funding and has some principles and a service-oriented mission that blends in very well with that. (Associate Director)	D

**Permitting Conditions**

Permitting conditions are any internal aspects of the libraries' situation that permit change to occur. Lundberg (1984) offers four examples of internal conditions that can make change possible. One is having a surplus of resources to manage the change, such as managerial time and energy or financial resources. A second example is the readiness and willingness of a principal coalition of staff to embrace the uncertainty of the pending changes. A third example is the extent to which the department is connected to and dependent on the larger whole. The final example focuses on the stability and influence of leadership; there needs to be some stability among the administrative membership and some degree of strategic awareness and competence in the power coalitions that exist in the local environment.

**Surplus of Resources**

In all the study sites directors and librarians commented on the lack of financial resources, indicating there were some limitations placed on what they sought to achieve. For example, in one library there was not enough money to hire three new people as desired, yet there were funds available for training existing staff; and in all cases, once it was demonstrated

over time that additional help was necessary to continue forward, funds were available to hire one or two new staff members as the e-science program started to take shape. However, resources are not limited solely to money. People, energy, and time are important elements of organizational resources. Each of the study sites had some critical resources on hand to contribute to the new direction.

Principal among these resources was a willingness of library administration to become involved. Through participation on university committees and in discussions with researchers and university administrators, library administrators became aware of a need for a systematic approach to data management across the institution. In some instances (libraries at sites B and D) where the institution as a whole operates as a decentralized organization the challenge to become involved has been greater. Yet, overall there were a number of internal resources available that library administrators could use as their foundation for involvement. Among these was skilled staff with a transferable expertise in a number of areas deemed critical to effective data management, such as cataloging, organizing, archiving, preservation, access and retrieval. As the Library Director at site C commented,

Someone has to do it and we are the ones that have the intellectual and theoretical knowledge to organize and allocate identifiers to data. You have to think of data as being analogous to collections. ... When people in the libraries question whether we should be involved, they've said, we don't get involved with research at the beginning. We get involved only with the publication of the result of the research by archiving it and making it accessible. ... I said, 'No that is not true.' Our archives, sitting upstairs have millions and millions of pieces of paper and monographs and rare books and

all kinds of things. They are really raw bits of data until a researcher, a humanist, or a social scientist comes in and uses them do they actually become research products. We are actually enabling and facilitating before the research process starts, if you think about what we are doing in archives and special collections. In a way, that is the way we think about the e-science datasets is that they are more or less, raw bits of non-tangible data that we have a responsibility to describe or assist in describing and that assistance is with sharing and ultimately if it is deemed appropriate by the researcher or community of researchers to preserve it.

Additionally, two other pre-existing elements were present in the libraries. First were department and/or subject-based liaison programs in which current relationships served as the basis for future working partnerships. Second, there were technology solutions (archiving systems and institutional repositories) and structures in place that expedited the libraries' involvement. According to Choudhury (2008), the institutional repository is "a 'gateway' to the underlying digital archive that will support data curation" (p. 211). He also states that institutional repositories can play an important role in supporting new forms of data-intensive scholarship, and "data have become a new form of publication, which are critical for [scientists'] research and teaching purposes" (p. 215).

### **System Readiness**

Library administrators and librarians simultaneously heard requests from researchers for assistance with managing data. At each site there was a small core of librarians who were interested in exploring and learning more about managing data. Librarians at site B explained it as a "grassroots effort" in which a small group of them began working one-on-one with willing

researchers to manage small data projects and build a base which future services would be modeled on. One Focus Group Participant at site C, supporting the “interested core” concept, had more to say about the level of engagement as he has witnessed it:

There are about 40 library faculty members and about a third of them are pretty keen on data. It is either [because they have] an individual research interest or it has impacted their job and they are very progressive in their thinking, very active. I would say there is another third in the middle that are open to it, interested in it. They come to the brown bags, maybe they are just getting their feet wet doing it or they are just being supportive, I don’t know. And there is another third, kind of the bottom third, who don’t perceive this as part of their job. It is not something they were trained to do in library school and for whatever reason they just haven’t or they just feel like they are too busy.

In the library at site D the approach is to move key staff into temporary leadership roles to help support and bring about new initiatives:

I am trying to break the culture that so many librarians have that is “we do good things and everyone knows it so why should we have to count it or to quantify it.” That simply doesn’t work from where I sit. Fortunately, I have a fairly substantial number of leaders who agree with that and see that. As we develop our annual refreshed strategic plan and decide the very specific initiatives we are going to be working on every year, my management team changes. I am calling it a strategic planning team and no one is there because of the position they hold. They are there because of the work we want to focus on during a given year. ... it has been



a very energizing force for the younger staff because it really focuses on not “who am I” but “what am I doing.” (Director at site D)

### **System Coupling**

Knowing the library is one element of the larger organization, the library administration at all sites reached out to other vested groups on campus (information technology, the office of research, and other faculty based committees) to identify issues and brainstorm solutions. These connections were primarily established through past working relationships and committee work, and provided an opportunity for all involved to become aware of each other’s services, expertise, future plans, and concerns. By working together as a group, when one part of the organization shifts into a new role the others are made aware and also have the opportunity to shift and grow.

### **Agent Power and Leadership**

Two points raised by Lundberg (1984) are pertinent here. First, his reference to leadership is in regard to the overall need for stability in the leadership and management team. Stability brings a level of constancy and consistency that individuals, teams, and organizations need during a time of transformational change. A lack of stability harms culture, stifles productivity, erodes trust, and makes it extremely difficult to retain top talent (Myatt, 2013). Instability can also be an indication of larger problems. The libraries in the study have all experienced stability across their upper level managers and in the director and associate director positions. They have sought to strengthen the library’s e-science and data management team by recruiting librarians who have a specific interest and skills in the area.

Second, Lundberg (1984) uses the term agent power to link the concepts of stability with a strategic awareness and competence in the local power coalitions. Bolman and Deal (2003) identify power as an important concept in their political structure frame. The political frame

looks at the work of a leader in terms of making decisions, resolving conflicts and allocating resources in the organization (Bolman & Deal, 2003). They identify a basic group of skills connected with this frame: (1) mapping the political terrain, (2) networking, (3) building coalitions, and (4) negotiating.

The libraries participating in the study clearly knew who the stakeholders on campus are and with whom they need to forge coalitions, specifically the campus information technology services and the office of research (in addition to individual researchers). The library leaders also know what the strengths and weaknesses of the library staff are and have a clear idea of where the library could and could not contribute. Table 5.2 compares Lundberg's permitting conditions with those noted by the investigator.

Table 5.3

*Summary of Permitting Conditions*

<b>Conditions*</b>	<b>Present in Case Studies</b>	<b>Examples from Case Studies</b>
Surplus of resources (time, money, people, and energy)	Yes	Willingness to get involved by library administration Transferable skills and expertise (cataloging, archives, digital humanities, evaluation, etc.) Pre-existing services (institutional repository services, liaison program, special collections, and archives programs)
System readiness	Yes	Core group of interested staff
Some system coupling	Yes	Partnerships formed with information technology services and the office of research
Agent power and leadership	Yes	Stability in leadership team and judicious use of power

\* Lundberg (1984).

## **Enabling Conditions**

Enabling conditions are external and environmental circumstances that increase the likelihood of transformational change occurring. Lundberg (1984) concluded that the extent of the threat of not changing (domain forgiveness) due to competitors, loss of finances, and customers looking elsewhere for services are important factors in enabling transformational change to occur. In addition, the degree to which supporting groups and customers are willing to tolerate the change, such as a break with a traditionally accepted or mutually agreed upon role, as well as the extent to which these stakeholders view the change as being too radical, can affect the environment and the circumstances in which the change occurs.

### **Domain Forgiveness**

The most influential external change propelling libraries to become involved in e-science is how digital technologies and investments in cyber and information infrastructure have fundamentally changed the way science is conducted. This change was noted in the National Science Foundation's *Cyberinfrastructure vision for 21st century discovery*, which stated that “converging advances in networking, software, visualization, data systems, and collaboration platforms are changing the way research and education are accomplished” (2007, p. 5). Scientific data are central to this transformation. Every day 2.5 quintillion bytes of data is created — so much that 90 percent of the data in the world has been created in 2010-2012 alone (Zikopoulos, Eaton, deRoos, Deutsch, & Lapis, 2012). In the sciences, these data can come from multiple sources (e.g., microarrays and sensors) and be in numerous formats (i.e., numerical and textual records, images, and sounds). This abundance is driving changes in the way universities view data, which are now seen as assets that the university wishes to protect and invest in, similar to buildings and people. Increasingly value is placed on both raw and processed data for potential

future uses such as selling or patent possibilities. Researchers and funding organizations are realizing that data have a lasting value. There is an awareness that research results could just as likely be in the form of datasets or parts of larger databases rather than as traditional journal articles (Lynch, 2008). University administrations are looking for a comprehensive solution and seeking the most efficient way to implement policy and procedures to address these issues, as well as how to store, preserve, and retrieve data so that data coming out of a research project are manageable. A university administrator from site A comments:

So first of all, are there policies for what we [universities] are actually going to do and provide? What are we going to have as far as a centralized repository? Are there going to be consultants that help people? How are we going to work with that? How is that going to be paid for? How are people going to buy into this? ... This is a big problem. This is a huge task. The University is big. There are a lot of different factions we have to worry about.

Setting policy becomes more complicated as the university places a greater emphasis on forming national and international collaborations to address global problems, with the goal of harvesting as much data as possible. As well, universities are bringing what were once isolated departments that are working on the same issue from different perspectives together under the formation of large institutes. Again a university administrator from site A speaks to the issues:

The biggest change is the establishment of very large institutes where people have gotten together under themes of research so we have the Institute of ... But the university has been very engaged in a multi-disciplinary, interdisciplinary work and has really been a pioneer in that area. This is a

continuation of that, people working with other collaborators and data management is just another step in that process.

### **Organization-Domain Congruence**

In exploring roles on campus, when a university administrator from site C was asked what was critical to the success of the institution's planning and implementation of services, he made the following comment:

Looking at things I would call critical, the thing would probably be individual success stories again. There are things that we talk about when we are trying to make an administrative initiative work and what you always need is a champion, a committed individual who is willing to give a little bit more than what they get back, in order to make something work. When it works it becomes a catalyst for the adoption or involvement of others. I think we've had that from the library in this area.

And,

Well, somebody has to take charge and I am pretty convinced that the libraries are the best central choice not just because of their historical role of providing information resources ... they are not learning, they are in a position to lead and they are also central but also have the tentacles out into the community. It is perfect. ... They also have the second resource that others don't have and that's the people whose careers are invested in moving this kind of enterprise forward. It is not sideline. It is a passion. You won't find that in any academic unit. You won't find it in any dean's office. (University Administrator, at site C)

An administrator at University B expressed a similar sentiment indicating that libraries are the natural home for data related services especially when it comes to long-term curation of data. There are many questions associated with data services that university administrators must consider, such as: What are the priorities; how will the services be funded; and are there any contractual obligations? The library is not in a position to answer all of these questions, but university administrators see the library as having something valuable to contribute to the conversation.

When three strategic partners from University C were asked if they viewed the library as a resource, a peer, or a partner, the answers showed the depth of services that the library has achieved and the relationship that was formed:

I would put all three. They continue to be resource. We are not going to invest in [repository software]. Why would we .... They continue to be a peer as we do these collaborative papers ... It is that whole peer faculty, colleague, staff exchange. As partners, I can't tell you I had this perfect vision of how to do this. I don't think they knew what we needed. How do you get together? When you get good people together, great things happen. The end product is better than the sum of the bits. (Strategic Partner 1, at site C)

And,

[We] have been working on a lot of projects side-by-side ... I see them as partners or peers. In fact, they have their own research projects .... We've written a few proposals together ... we've got a joint team that [a librarian] leads but it is kind of a joint team in terms of development. (Strategic Partner 2 at site C)

And again,

Partner because the way I come to view it is that, I am a field researcher, a field / lab researcher. I work at one scale. I collect one sort of things. I will use for my own program to answer the question I initially had when I designed the experiment and then I am done. If I am even to make it available to [other researchers] down the street, it has become painfully evident that we need some help from people who are linguists. It is not just translating for us or trying to figure out the language that we communicate in. It is developing it and getting us to agree, “I am going to call this, this. This is what you call it. We have to come to an agreement about an agreed term.” So they are an active research partner in trying to understand the disconnects between how the disciplines communicate. I mean I am a discipline and there is another discipline and I am painfully aware that we don’t communicate. But I am not likely the person who is going to develop, research, identify, and implement the communication process, tools, framework, etc. So they are full partners, otherwise we are not going anywhere. (Strategic Partner 3 at site C)

The relationship that librarians at site C formed with members of the research community was unique in this study. The acceptance of librarians as equals who have something valuable to contribute was not only voiced, but put into action and welcomed. Table 5.3 summarizes Lundberg’s conditions compared with the enabling conditions gathered by the investigator.

Table 5.4

*Summary of Enabling Conditions*

<b>Conditions*</b>	<b>Present in Case Studies</b>	<b>Examples from Case Studies</b>
Domain forgiveness	Yes	Computational science and amount of data being generated Collaboration, formation of large institutes Value placed on raw data Comprehensive solution needed, seeking institutional efficiencies
Organization-domain congruence	Yes	Library is viewed as having a role by university administration

\* Lundberg (1984).

### **Pre-Existing Conditions**

Pre-existing, or precipitating conditions, according to Lundberg (1984), include the predisposition of an organization to grow and/or decline, to perform above or below expectations, the frustration experienced by organization members at the emergence of new unmet needs, external pressure from stakeholders who have a vested interest, and a real or perceived crisis. This combination of past experiences and the historical response to those experiences influences future changes.

### **Organizational Growth and Decrement**

For many years now libraries have been asked to do more with less. The economic crisis of 2007-2009 brought that issue to the forefront of many who work and provide services in libraries. Instead of being paralyzed by economic hardships, library leaders took the opportunity to fine tune their mission, develop transition strategies, and rethink how library staff can capitalize on their distinctive capabilities (Dougherty, 2009; Nicholas, Rowlands, Jubb, & Jamali, 2010; Ross & Sennyey, 2008). This includes leveraging human and material resources,



setting priorities, and becoming even more closely aligned with a university's mission. The library has a long history of changing with the times, adjusting services, and continuing to add value along the way (Gilchrist, 2007; Holloway, 2004; Mullins, 2009; Neal, 2001).

In the instance of e-science and the new role of data management, the four libraries focused primarily on growth. The library directors at each site indicated the new direction was something that was being built on past performance and/or an existing skill set, such as cataloging print materials transitioning to applying metadata standards, or teaching information literacy skills evolves into teaching best practices for data management. Primary among the experiences mentioned was assuming a key role in developing information policies (such as considerations of an open access resolution and copyright guidelines) for the institution. The library director at site B explains, "When data issues come along, the faculty and the administration naturally think about engaging the libraries just because we've been advocating for the right kind of information policies for a long time. A lot of pieces come together."

As well, the directors at sites A, B, C, and D mentioned that having a long history of teaching and demonstrating new technologies provided evidence of important skills that faculty respected and proved to be an asset as librarians started to teach courses in data management. A Focus Group Participant from site C noted:

My instruction is ramped up. My outreach is ramped up then the e-science came on board as well. I was involved with that since it involved outreach. ...  
For me, the biggest efforts have been in information literacy, instruction, ...  
and then e-science.

At each site university administration viewed the library administrators (director and associate directors) as being leaders in their field capable of leading the institution in this new

area. As an administrator from University C said when discussing the libraries' readiness to assume a leadership role in data management on campus:

Somebody has to take charge and I am ... convinced that the libraries are the best central choice not just because of their historical role of providing information resources to faculty members at a university in general but because the research interests, the scholarly interests of the people in the libraries have already moved into the domain.

Each of the library directors and associate directors commented on tasks that staff could stop doing in order to funnel time and resources to the new e-science and data management initiatives. The library director at site A commented on the government documents librarian, who was actively promoting the geographic information system (GIS) datasets and becoming an expert in their application as use of the paper-based government document collection declined. The desire was expressed by the library directors at sites B, C, and D to focus less on the building and paper-based collections contained within the physical structure. The following observation was made by a university administrator from site B when speaking about the physical space of the library:

In a meeting recently the Libraries came up, and it's clear to me that a lot of people still have a very 19th century vision of libraries, place based, as oppose to information portals. Changing the mindset of the campus is not a negligible step that's needed. Maybe that's less of a problem for the younger generation [of faculty].

## **Stakeholders**

Stakeholders are those people or departments with an interest in or have some relationship with the library. The confidence placed in the library by university administration is based on the library's strong commitment to the university's mission. The library director's at all four study sites spoke of a strong commitment to their local campus community needs. The interests and information needs of the faculty, researchers, and students drive the programs and services that the library develops and offers.

At sites A and B both the university administrators and the library directors interviewed commented on how the library collectively works towards a common mission (see Table 5.5). The two libraries are clearly in harmony with their larger institution mission. At University A the administrator spoke of the importance of research that occurs at the institutions and expressed concern about the management of the data that results from the research. The library echoes the importance of research to the university mission and identifies the specific role of the library: "The Library integrates and manages knowledge to enable learning and the creation of new knowledge" (University A, Administrator).

The library and university administrators at site B are also in accord. Both mention the keywords of the university mission, learning, discover, and engagement. The administrator comments on e-science as a critical part of discovery, and the library director calls the library a partner in these endeavors and links the library mission to the university mission.

Table 5.5

*Mission Alignment*

<b>University A</b>	
<b>University Administrator</b>	<b>Library Director</b>
<p>The mission of University is undergoing some changes. Research, teaching and service are the three main ones. If you talk about those certainly it is how research is handled and processed here on the campus. But more directly ... how we are dealing with collaborators and sharing that information. ... We have to reevaluate that as an institution to see how we are going to facilitate that and get beyond some of the basic questions ... not only how we are going to handle it from a functional scale or how we are going to handle massive datasets but also how we are going to meet researchers expectations for handling the data.</p>	<p>The University Library is central to the intellectual life of the University. By providing and stewarding collections and content that comprise a current and retrospective record of human knowledge and by offering a wide array of services, it enhances the University's activities in creating knowledge, preparing students for lives of impact, and addressing critical societal needs. The Library advances the University's goals by ensuring unfettered access to information and by providing a network of expertise that ensures value, quality, and authenticity of information resources. The Library integrates and manages knowledge to enable learning and the creation of new knowledge.</p>
<b>University B</b>	
<b>University Administrator</b>	<b>Library Director</b>
<p>There is a three-part mission ... Learning, discovery with delivery and engagement. ... on the engagement side, making the outcomes available as broadly as possible whether that is something that being required by a federal funding agency or whether it is just in the culture ... From my point of view e-science is a big part of it is this discoverability, availability, and provenance.</p>	<p>The Libraries are partners with the schools and departments of the University in meeting the discovery, learning, and engagement commitments of the University.</p> <p>The Library's primary role is embodied in five components of the mission: information transfer, a partner in teaching and lifelong learning, a partner in discovery, a partner in engagement, and a repository of the intellectual record.</p>

## **Real and Perceived Crisis**

A crisis can be defined as “an unstable condition involving an impending abrupt or significant change that requires urgent attention and action to protect life, assets, property, or the environment” (ASIS International, 2009, p. 45). In this instance, the crisis was more about not being part of the solution. The ARL Task Force on E-Science was one of the first groups to point out that e-science trends were evolving rapidly, and libraries could miss opportunities for contribution and engagement as this form of research evolved if they did not act fast. “In short, research libraries are potential partners in e-research, yet our existing expertise and infrastructures will be seriously stretched by the new, more complex demands of e-science” (Joint Task Force on Library Support for E-Science, 2007, p. 6). In order for the librarians to be considered partners, they need to be engaged actively with their research communities and understand the concepts of the domain and the methodologies and norms of scholarly exchange. This level of understanding and engagement requires being a trusted member of the community with recognized authority in information related matters.

The library administrators and librarians in the study, without saying it directly, were responding quickly and as if a crisis was at hand; they needed to retain value. Crisis management can be defined as a "holistic management process that identifies potential impacts that threaten an organization and provides a framework for building resilience, with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand, and value-creating activities - as well as effectively restoring operational capabilities" (ASIS International, 2009, pp. 45-46). Library management at the study sites indicated that it was critical for the library to be involved in order to maintain the reputation and continue to be viewed as a valuable campus asset.

## Performance Demands

Both the NIH and the NSF view the services and technologies needed<sup>1</sup> for advancing e-science as complex and massive. The required infrastructure includes education and workforce development and a comprehensive integrative program to support collaborations of multi-disciplinary teams and communities (National Science Foundation, 2012). As university communities try to address the same requirements (Lynch, 2008), university administrations have acknowledged that no one department or office is capable of meeting all the needs on its own. The creation of the underlying infrastructure requires teamwork and collaboration to develop a comprehensive plan. The library is often viewed as a neutral place on campus with a long history of collaboration and important skills to contribute.

The library at site C has been working with research departments and individual researchers, in contrast to information technology services, which are viewed more as a utility than as a collaborative service. This has placed the library in a position to help facilitate the conversation around research data needs without going beyond their expertise. Similarly the library at site D, librarians state that they have a good understanding of preservation and curation, but when it comes to visualization tools, high-performance computing, storage, and data mining, they recognize they are not the leaders but they know who on campus is, and the library partners with them. Table 5.4 summarizes Lundberg's conditions compared with the enabling conditions gathered by the investigator.

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<sup>1</sup> These services and technology include the scientific and technological means of managing, analyzing, visualizing, and extracting useful information from large, diverse, distributed, and heterogeneous datasets.

Table 5.6

*Summary of Pre-existing Conditions*

<b>Conditions*</b>	<b>Present in Case Studies</b>	<b>Examples from Case Studies</b>
Organizational growth and decrement	Yes	History of advocating for information policy and management Library has responded successfully to new initiatives in the past History of teaching and demonstrating new technologies Library has a voice through participating on university committees Selective downsizing of services
Performance demands	Yes	Willingness to collaborate
Real and perceived crisis	Yes	If library does not get involved proactively it will be left out
Stakeholders	Yes	Strong service focus to mission of institution and supporting research

\* Lundberg (1984).

### Triggering Events

With the buildup of permitting and enabling conditions and the pressure of pre-existing conditions, any event or activity that creates turmoil (crisis, recession, or a new competitor) or an opportunity (new needs, excess resources, and technological breakthroughs) can catapult an organization into change. As well, Lundberg (1984) considered events such as a turnover in management (e.g., hiring a new leader with a new vision), a new trend or movement, new legislation, and mergers and acquisitions to be triggering events. In the study sites a number of consistent triggering events occurred.

All of the site libraries have been thinking about e-science and data management for the past 10-15 years. In this time frame there have been a number of triggering events. None of the site

libraries identified any environmental calamities or managerial crises. Rather, they viewed many of the triggering events as positive experiences which gave the libraries' staff an opportunity to display their unique skills and fill a crucial need.

### **Environmental Opportunities**

The site libraries identified two distinct opportunities. One occurred on the local level. Libraries at sites A, B, and C shared instances in which prominent local researchers who were coming to the end of their research career contacted the library to transfer the data that they had accumulated. Most of these data were presented to the library as having value to a specific research audience, and needing significant curation work to make them useful to that audience. In these instances, since the data were viewed as historical, the libraries welcomed the opportunity to demonstrate their value by transitioning the datasets into a hybrid special collection and data management project. These projects showcased the libraries' willingness to work with researchers and add new value to existing datasets. These projects were promoted to others as examples of the libraries' work.

The second, environmental opportunities shaping library involvement in e-science and data management are national events that affect researchers and thus filter down to the local level. In the past decade, declarations from two key funding agencies in the United States have brought attention to the value of making data resulting from publicly-funded research openly available. Starting in 2003 the National Institute of Health (NIH) has required investigators submitting an NIH application seeking \$500,000 or more in direct costs in any single year to include a plan for data sharing or state why data sharing is not possible. In 2010, the NSF followed its example:



Investigators are expected to share with other researchers, at no more than incremental cost and within a reasonable time, the primary data, samples, physical collections and other supporting materials created or gathered in the course of work under NSF grants. Grantees are expected to encourage and facilitate such sharing. (National Science Foundation, 2013, D. Intellectual Property, 4. Dissemination and Sharing of Research Results, Section b)

These two events focus on data; however, the NIH Open Access policy from 2008 requires scientists to submit final peer-reviewed journal manuscripts that arise from NIH funds to the digital archive PubMed Central upon acceptance for publication. Recent bills<sup>2</sup> focus on published journal articles, often thought of as the finished product of research and not the actual research data generated throughout the process. The bills require that U.S. government agencies with annual extramural research expenditures of over \$100 million make manuscripts of journal articles stemming from research funded by the government freely accessible and reusable via the Internet.

In general, federal mandates provide an important opportunity for libraries because they were so closely tied to what is important to the researchers, their funding source. As a result, just when the researchers are looking for assistance in understanding the mandates, the libraries began providing educational programing; early on the libraries established their authority in these areas and continue to monitor national and local events closely:

What the next big frontier will be is really hard to say but there will be some big changes, there is no question about it. Of course, part of it depends on what happens in the election too. Politics play a big role particularly in areas

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<sup>2</sup> More recently, the Fair Access to Science and Technology Research Act (FASTR) was introduced in Congress on February 14, 2013 and the Public Access to Public Science Act (PAPS) on September 19, 2013. See Chapter 1 for more details.

like ours. [University D] has been, for the last thirty plus years, receiving ... federal research dollars ... so we really keep a very close eye what is happening with federal funding for research because of such a huge part of how we fund our operations. I am expecting that even the results of the presidential election will have a fairly direct, although not immediate effect on what the library does and how it does it. I think people who are in jobs like I have now, have to keep a broad - we talk about environmental scans. It is a very large environment we are looking at. (Library Director at site D)

### **External Revolutions**

Along with the two data-sharing requirements mentioned above, the open access<sup>3</sup> and open data<sup>4</sup> movements, coupled with the overall changes in scholarly communications, were viewed as stepping stones for the four libraries to start engaging with the research community on a new level regarding their research. Initially the librarians at the four sites had more experience talking about open access than they did data management. Over time, as new tools<sup>5</sup> become available to assist with data management, librarians become more involved and were more comfortable discussing options with researchers.

Scientific publishers are also continuing to modify their policies to balance what is happening at the federal government level. Effective May 2013 a condition of publication in any of the journals published by *Nature* is that the authors make materials, data, and associated protocols promptly available to others without restrictions. Datasets must be made freely

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<sup>3</sup> Open-access (OA) literature is defined as digital, online, free of charge, and free of most copyright and licensing restrictions (Suber, 2013).

<sup>4</sup> Open data are data that can be freely used, reused, and redistributed by anyone. The one requirement is to attribute authorship and maintain a Creative Commons license (Open Knowledge Foundation, 2012).

<sup>5</sup> HUBzero (<http://www.hubzero.org>), Cytobank (<http://www.cytobank.org>), and WebPAX (<https://www.webpax.com/>) are examples of such tools.

available to readers from the date of publication, and must be provided to editors and peer-reviewers at submission, for the purposes of evaluating the manuscript ("Announcement: Reducing our irreproducibility," 2013). Nature Publishing indicates that the motivator for this change in policy is to “improve the transparency of reporting and the reproducibility of published results” (Nature Publishing, 2013, Reporting requirements for life sciences research section, para.1).

Despite the close relationship among open access, open data, and scholarly communications, the library at site A is the only one in the study that, when reorganizing, decided that scholarly communication services and data management consulting would be offered by the same group, taking a broader view of research services. The library repository manager at site A speaks of her expanding duties:

When I got started doing institutional repository work, the first two or three years were really focused on getting the repository set up and doing some of the typical outreach work that many IR managers were doing. But in the last four years, I’ve become much more involved in issues around scholarly communications, so broader than just the repository including things like copyright, working with faculty around copyright transfer agreements and publication agreements, working around data, and doing consulting around data services.

### **Internal Revolutions**

The internal changes identified at the libraries participating in the study are few but taken together have had a major impact on the success of the e-science and data management programs. One common occurrence in the libraries was the initiative, drive, and leadership of

one or more individuals. For Library C one of those individual was the new library director, who proactively asked researchers what they needed in terms of data management and advocated for the library to be the one to fulfill those needs. In all of the libraries studied a particular staff member, existing or newly hired, was willing to embrace the new role the director identified and served as an inspiration and mentor to others.

Operationally, each of the library directors found it necessary to reorganize the internal structure to provide the new services that e-science and data management necessitated. However, e-science was not seen as the only instigator of the reorganization. The changing nature of the work the library was performing, such as cataloging shifting into metadata and liaison librarianship migrating to the idea of an embedded librarian, was an equal contributor. Table 5.6 is a summary of the Lundberg conditions compared with the triggering events as gathered by the investigator.

Table 5.7

*Summary of Triggering Events*

<b>Conditions*</b>	<b>Present in Case Studies</b>	<b>Examples from Case Studies</b>
Environmental calamities	No	
Environmental opportunities	Yes	Desire among researchers/institution to preserve legacy National Science Foundation and National Institute of Health DMR National Institute of Health Public Access Policy
Managerial crisis	No	
External revolutions	Yes	Emergence of discipline based metadata standards Major grants Open data/open access movements

Internal revolutions	Yes	New library director (Library C) Key staff already in place Hiring of new staff Reorganization
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\* Lundberg (1984).

### Conclusion

Examining the question of why an organization undergoes a change from the perspective of permitting, enabling, and pre-existing conditions, as well as the triggering events, provides a framework in which to analyze a complex situation. Figure 5.7 summarizes these conditions as experienced by the study sites. The first two types of conditions, permitting and enabling, set the library up for a transition. There was a willingness of the library administration to get involved; key staff members who were interested in participating; and a clear vision for library involvement and programs, services, and librarian skills to build on. These permitting conditions, in conjunction with a series of enabling conditions such as the rate of growth of research data and that data being viewed as having value as a standalone asset, the formation of large (cross-country and international) research institutes, and the desire for a strategic approach to building a stable long-term infrastructure, put the library in the center of the issue.

The permitting conditions facilitate change. The libraries' strong service focus and willingness to collaborate with research teams, their long tradition of teaching and demonstrating the application new technologies, as well as being well positioned in the university and advocating library services at university committee meetings, helped to advance the libraries' efforts to be involved. As data management became an issue of external compliance and funder requirements (an example of a triggering event), university administrators turned to the library for advice and leadership. Not all the libraries experienced each of the variables listed in Table

5.7, or experienced those to the same extent; however, there is evidence to detect that a transformational change is possible.

Why an organization undergoes change is just the first part of the question. How the organization goes about implementing the change is equally important. Change efforts can fail for a number of reasons, including culture, bureaucracy, politics, low level of trust, lack of teamwork, poor attitude, lack of leadership, and fear (Kotter, 1996a). Yet, when a clear vision is formalized and a process for change is followed, the possibilities for transformational change to occur increase. This is the focus of Chapter 6.

Table 5.8

*A Model of Transformational Transitioning\**

Under circumstances of		
<i>Internal permitting conditions</i>	<b>in conjunction with</b>	<i>External enabling conditions</i>
<ul style="list-style-type: none"><li>• Willingness to get involved by library administration</li><li>• Core group of interested staff</li><li>• Vision is shared and accepted by core</li><li>• Pre-existing services (institutional repository services, liaison program, special collections and archives programs)</li><li>• Transferable skills and expertise (cataloging, archives, digital humanities, evaluation)</li></ul>		<ul style="list-style-type: none"><li>• Computational science and amount of data being generated</li><li>• Collaboration, formation of large institutes</li><li>• Value placed on raw data</li><li>• Comprehensive solution needed, seeking institutional efficiencies</li><li>• Library is viewed as having a role by university administration</li></ul>
<b>and</b>		
<i>Precipitating conditions</i>		
Strong service focus to mission of institution and supporting research		
Library has responded successfully to new initiatives in the past		
History of teaching and demonstrating new technologies		
Willingness to collaborate		
Selective downsizing of services		
Library has a voice through participating on university committees		
History of advocating for information policy and management		
<b>An organization which experiences certain</b>		
<i>Triggering events</i>		
Major grants		
Hiring of new staff		
New library director		
Reorganization of Staff		
Key staff already in place		
Open access/open data movement		
National Science Foundation and National Institute of Health DMR		
Desire among researchers/institution to preserve legacy		
Emergence of discipline based metadata standards		
<b>May lead to transformational change</b>		

\* Model based on the work of Lundberg (1984).

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## Chapter 6

### THE STAGES AND PROCESS OF CHANGE

According to Conner (1993b), the key elements and flow of events involved in change represent a framework “composed of both patterns and principles – the structure of change” (p. 88). Process models of change describe the sequence of events necessary to effect organizational change, focusing more on the essential steps of implementation than on the conceptual tasks required (Latta, 2009). Most organizational change process models are based on Lewin’s (1947) classic three-stage model of change as described in Table 6.1. Subsequent process models outline sequences of events that elaborate upon these essential underlying stages of change to varying degrees (Bate, Khan, & Pye, 2000; Burke, 2008; By, 2005; Conner, 1993a; Galpin, 1996; Hiatt, 2003; Judson, 1991; Kanter, Stein, & Jick, 1992; Kotter, 1996a; Luecke, 2003; Mintzberg & Westley, 1992; Reardon, Reardon, & Rowe, 1998).

Table 6.1

#### *Three Step Change Model\**

Phase	Action
Unfreeze	Create initial motivation to change by convincing people that the current state is undesirable
Change	Identify new behaviors and norms; communicate; and adopt a new attitude and culture
Re-freeze	Reinforce new behavior through reward systems, communications and structures

\* Based on the work of Lewin (1947).

#### Review of Other Related Change Models

The change management continuum developed by Conner (1993a) is not incorporated in this study because its main focus is on resistance to change. The Beer, Eisenstat, and Spector

(1990) model was specifically not included because its developers believe that change is only about work alignment and do not deal with “abstractions like participation and culture” (p. 159). Rather, they propose a model that focuses on change that comes from the bottom up and does not require the support of senior management. Prosci’s ADKAR (Awareness, Desire, Knowledge, Ability, and Reinforcement)<sup>1</sup> (Hiatt, 2003) and other models (Armenakis, Harris, & Mossholder, 1993; Pettigrew & Whipp, 1993) that are more conceptual in nature than process driven were also dismissed. Judson (1991), Kanter et al. (1992), Kotter (1995), and Luecke (2003), however, provide relevant change models because of their emphasis on a step-by-step approach.

**Judson.** According to Judson (1991), with all the uncertainties executives and managers must deal with in organizations, the one thing they can count on is change. To remain viable, an organization must continuously change the way it operates in order to improve performance and implement its strategy. When confronted with change, people are more likely to resist than to support it. This applies not only to those directly affected, but also to those lower-level managers and supervisors who are often crucial to carrying out the change. Judson (1991), focusing on how people feel about and behave in response to change, developed a comprehensive and systematic approach to the management of any change which will transform the likely opposition of those affected and involved into support for making the change work.

Judson (1991) addresses one of the most difficult and important elements of management: how to approach and manage change to get the desired results. His five steps to change are:

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<sup>1</sup> Founded in 1994, Prosci Inc. is a research firm specializing in the field of change management. Prosci has developed a set of common language, customized tools and training programs to facilitate the change process for global organizations. Prosci's globally recognized ADKAR® model has become one of the most used change management models throughout the world, with an emphasis on helping organizations build internal competency to lead change, from top-level executives to front-line employees (Prosci, 2013).

1. analyze the change;
2. communicate the change;
3. gain acceptance of the new behaviors;
4. change from the status quo to desired state; and
5. consolidate and institutionalize the new state.

**Kanter.** Kanter et al. (1992) argue that Lewin's model for change (see Table 6.1) is based on a view that organizations are essentially static and stable. They disagree with the idea that change results only from concentrated effort and that it happens in one direction at a time. They argue that change is multi-directional and ubiquitous; in other words, it happens in all directions at once and is more or less a continuous process.

Kanter et al. (1992) identify two types of change. The first is referred to as "bold strokes" (p. 492). These are major strategic or economic initiatives taken at the top of the organization that have a rapid and significant impact, but do not change culture and do not rely on cooperation from the rest of the organization for success. The second approach is called "long marches" (p. 492). These are smaller initiatives to create long-term change at the operational level. These initiatives can change culture, but widespread involvement and support from employees are necessary for success. Both approaches to change use the same 10 step process (Kanter et al., 1992, p. 383):

1. analyze the organization and its need for change;
2. create a shared vision and common direction;
3. separate from the past;
4. create a sense of urgency;
5. support a strong leader role;

6. line up political sponsorship;
7. craft an implementation plan;
8. develop enabling structures;
9. communicate, involve people, and be honest; and
10. reinforce and institutionalize change.

**Kotter.** Kotter (1995, 1996a, 1996c, 1998, 1999, 2005a, 2005b, 2008a) has written extensively in the management and leadership literature about his model for organizational change; his work is recognized as seminal. He began his study of organizational change in the mid-1980s and within a decade he “watched more than 100 companies try to remake themselves into significantly better competitors” (Kotter, 1995, p. 59). Kotter observed large and small companies based in the United States and elsewhere, including companies that were prospering at the time of change and those on the brink of failure. As a result of those observations, he identified two lessons: one, that change takes time and skipping steps to speed up the process is not effective, and, two, that critical mistakes in any of the phases can have devastating impact, slowing momentum and negating hard-won gains.

Kotter (1996a) established his model for change in response to a set of eight problems he recognized in organizations that failed to complete a planned change, and so he offered eight steps to producing successful change of any magnitude in organizations:

1. establish a sense of urgency;
2. form a powerful guiding coalition;
3. create a vision;
4. communicate the vision;
5. empower others to act on the vision;
6. plan for and create short-term wins;

7. consolidate improvement and produce more change; and
8. institutionalize new approaches.

**Luecke.** Luecke (2003) identified two types of change, Theory E and Theory O. The former is based on an economic approach. The explicit goal is to increase shareholder value dramatically and rapidly, specifically to improve cash flow and increase share price. Working from the top down, the executive team drives Theory E changes; usually outside consultants are hired to work with an executive team to strategize and implement changes. In these instance departments, units, and employees are viewed as pieces on a “chessboard.” In contrast, the goal of Theory O change is to develop an organizational culture that supports learning and a high-performing employee base; the emphasis is on individual and organizational learning. Theory O necessitates high levels of employee participation, a flatter organizational structure, and solid connections between the organization and its employees. Leaders of Theory O change are less concerned with directing the change themselves than inspiring involvement from across the organization, and in fostering employee behaviors and attitudes that will withstand the changes. Building on the work of Beer et al. (1990), Luecke (2003) proposes seven steps to follow when implementing either type of change:

1. mobilize energy and commitment through joint identification of business problems and their solutions;
2. develop a shared vision of how to organize and manage for competitiveness;
3. identify leadership;
4. focus on results, not activities;
5. start change at the periphery, and then let it spread to units without pushing it from the top;
6. institutionalize success through formal policies, systems, and structures; and



7. monitor and adjust strategies in response to problems in the change process.

### **Case Study Change Process**

In the data collection process and the subsequent thematic analysis, the investigator identified seven common steps that the participating libraries discussed during their implementation of e-science programs and services. The steps, which were first mentioned in Chapter 4, are:

1. identified need;
2. decision to act;
3. resources assigned;
4. partnerships formed;
5. paradigm shift;
6. demand increases; and
7. institutionalization of changes.

### **Identified Need**

Kuhn states that "awareness is prerequisite to all acceptable changes of theory" (1996, p. 67). Externally, library personnel (administrators and librarians) at each of the sites included in the study were learning of the impact data-driven science has on researchers' methods and processes for storing and accessing data. Concurrently, opportunities for libraries to participate and get involved were identified by library organizations (Joint Task Force on Library Support for E-Science, 2007) and leaders in the library profession (Atkins et al., 2003; Borgman, 2007; Brant, 2007; Hey & Hey, 2006; Mullins, 2007, 2009, 2010; Neal, 2001; Rambo, 2009). Simultaneously, library administrators and librarians became aware of a growing need for data management services, especially in the area of educational programing. Library administrators

learned of this need at the institutional level through committee work and networking events, while librarians who were engaging in one-on-one discussions about opportunities to support researchers heard that data management was a growing problem.

Table 6.2 provides brief excerpts from the comments library administrations shared with the investigator while articulating the need across the institution for new services and programs to be created. The directors at sites A, B, and C spoke to the scope of the issue. The issue is not just relevant to one or two researchers or departments: it cuts across the entire campus and a comprehensive systematic solution is necessary. The quote from the library director at site D speaks to the role of the library and opportunities that are present for the library that is willing to act. In all of these statements the explicit understanding is that only through making a change and through collaboration will a solution begin to emerge.

Table 6.2

*Comments to Support Process to Bring About Changes: Identified Need*

Step	Supporting Interview Comments
Identified Need	<p>“The expectation of every tub on its own bottom in terms of research output and research longevity that was a model that was way broken, not going to work.” (Library Director, site A)</p> <p>“there are more communities across campus recognizing the importance of this topic [data curation].” (Library Director, site B)</p> <p>“This is a huge problem and there are enormous amounts of work that needs to be done ... people who could be helping advance it, aren’t doing it because the need hasn’t been fully articulated ... .” (Library Director, site C)</p> <p>“I need a librarian to do this and I think you have the people who can do it. This is a really important priority. From day one we have been aware and committed to doing this.” (Library Director, site D)</p>

**Decision to Act**

The library directors at the study sites agreed that the identified need aligned with the larger vision for the library and made the decision to act. The library director from site A stated that once the need has been established and the opportunity for library involvement identified, the institution (and the library by default) has a fiduciary responsibility to get involved (see Table 6.3). The director from the library at site B regards its involvement as a natural progression from to its previous campus role in information policy development and advocacy. At site C, the library director’s motivation to act stemmed from the skill set of the library administration and staff. There was a strong sense among campus administrators that the library was well positioned to assume a leadership role and guide the campus-wide effort; the library willingly responded. The library director at site D realized that the library was responding to researcher needs for data management, but one particular staff member was the only one providing services and those services were externally funded. As the needs increased across the institution, the library as a whole had to follow suit and respond formally to the demand. As a result, when the decision to act was made and a plan was developed, the implementation was easy to begin because staff members were aware of the importance and they were part of the decision to move in a new direction.

Table 6.3

*Comments to Support Process to Bring About Changes: Decision to Act*

Step	Supporting Interview Comments
Decision to act	“But I think that one of the most important things is that in the absence of anything, we know, still, that we have a responsibility, even if it is just a fiduciary responsibility to manage the data that is produced from federally funded research.” (Library Director, site A)

Table 6.3 (*continued*)

*Comments to Support Process to Bring About Changes: Decision to Act*

Step	Supporting Interview Comments
Decision to act ( <i>continued</i> )	<p>“When data issues come along, the faculty and the administration naturally think about engaging the libraries just because we’ve been advocating for the right kind of information policies for a long time.” (Library Director, site B)</p> <p>“We have found that this growing concern about the needs in e-science has been expanding and that we are the ones on campus who can help.” (Library Director, site C)</p> <p>“The data piece is specific enough that we should approach it in a dedicated way.” (Library Director, site D)</p>

**Resources Assigned**

As the staff at the libraries worked to make the actual transition from the current state to a future state, a critical step involved assigning the necessary resources (people, money, space, and technology) to the new e-science program. Library administrators at each of the sites realized the importance of deploying resources in support of the e-science goals by providing the staff with the tools they needed to do their job well, specifically by supporting additional training and education programs, hiring new staff, and allowing time for the programs and services to grow based on environmental scanning and local needs. Table 6.4 demonstrates the commitment to assign physical resources long-term by library administrators. Directors at sites A and D specifically mention additional staff, whereas the directors at sites B and C remarked on the commitment to move forward in a formal process, assigning the necessary resources as they are identified.

At a structural level, the libraries also took steps to change the organization, for example, by creating and/or modifying major structures and processes. These included adding new departments and staff, as well as providing training on new policies and procedures. Furthermore, to advance e-science, there continued to be strong, clear, and ongoing communication about the need for the change, the status of ongoing change, and solicitation of staff members' continuing input to the change effort.

Table 6.4

*Comments to Support Process to Bring About Changes: Resources Assigned*

Process	Interview Comments
Resources assigned	<p>"We have several librarians who focus on working with research data ...GIS ...social science data ... physical sciences data. We are beginning to develop the capability to deal with life sciences and biomedical data as well." (Library Director, site A)</p> <p>"I think it is the formalization of a lot of things that we had been doing informally because we were interested and we were squeezing it into our job." (Focus Group Participant, site B)</p> <p>"When we do focus on things like e-science ... we are making explicit decisions that this is an area and divide it up to say we are going to explore it this way. If we decide that we need to put recurring resources behind it then we make that decision." (Library Director, site C)</p> <p>"We have two librarians who are in the role of data management consultants who came on board ... last year." (Associate Director, site D)</p>

## Partnerships Formed

Two types of partnerships were formed at the study sites. The first involved partners from across the institution who were interested in providing data services or had a vested interest in services being offered on a large scale. In all study sites the library joined efforts with the office

of research and the office of information technology services. These three groups worked together to identify institutional data related issues of mutual concern. Librarians at sites A, B, and D spoke about these new institutional partnerships, especially with research and departmental administrators (see Table 6.5). The task of complying with the National Institute of Health (NIH) Public Access Policy<sup>2</sup> often fell to department administrators. As the libraries reached out to researchers to work with them on complying with the policy, the librarians were directed to department administrators.

The second partnerships described by the site libraries were those formed between individual librarians and individual researchers or research team members. Librarians at site C speak to these newly formed relationships (see Table 6.6). The librarians are shifting into an embedded role and providing customized data services and instructional sessions. In these instances the librarians have defined functions and responsibilities to support the research activities on the research team. These librarians support multiple projects within the university. When one project ends, the librarian shifts that percentage of focus to another existing or new project.

Table 6.5

*Comments to Support Process to Bring About Changes: Partnerships Formed*

Process	Interview Comments
Partnerships formed	“We’ve made a more concerted effort in the last five years to be much more involved with research administration, in terms of new research interests and new research fronts.” (Focus Group Participant, site A)

<sup>2</sup> The NIH Public Access policy requires researchers to submit final peer-reviewed journal manuscripts that arise from NIH funds to the digital archive PubMed Central upon acceptance for publication.

Table 6.5 (*continued*)

*Comments to Support Process to Bring About Changes: Partnerships Formed*

Process	Interview Comments
Partnerships formed ( <i>continued</i> )	<p>“[E]xamples ... working with staff who are not faculty and students per se but who are computing lab managers or people who are responsible for data management issues ... people whose job is to manage information in that department not just people whose job it is to find secondary information;” “We find ourselves working more closely with outside departments.” (Focus Group Participant, site B)</p> <p>“That has involved things like ... pushing librarians out into the departments more so that they [faculty] are interacting as people as opposed to going into the library and talking to whatever librarian is there, embedding within the different departments and getting more relationships built and that has led to things like data services and more instructional opportunities.” (Focus Group Participant, site C)</p> <p>“They [department administrators] have been a really important partner and we recognized that early on and built that relationship solidly.” (Focus Group Participant, site D)</p>

According to Goosen, true collaboration is a long-term process, often going through many revisions as environment and relationships change. There are multiple levels of partnerships (Goosen, n.d.):

- networking: simply sharing information for the benefit of both parties;
  - coordination: a willingness to alter activities to achieve a common purpose;
  - cooperation: a form of partnership that builds on coordination by sharing resources;
- and

- collaboration: includes not only the exchange of information, altering activities, and sharing resources, but also enhancing the capacity of other partners for mutual benefit and to achieve a common purpose.

In two instances the investigator spoke with a representative from university administration (one each at sites A and C) and in one instance the investigator talked to strategic partners (three from site C). The administrators, strategic partners, and librarians experienced the range of these partnerships, which often started out as networking but grow to be a full collaboration. All of the relationships were mentioned as advancing the library's involvement in e-science and the goals the library was seeking to achieve.

### **Paradigm Shift**

A paradigm shift is a change from one way of thinking to another. It is often categorized as a revolution, a transformation, or a sort of metamorphosis. It is not something that happens on its own, but rather is driven by agents of change (Kuhn & Hacking, 2012). Building on the original work of Kuhn (1962), Levy and Merry (1986) define the term organizational paradigm as “the metarules, or conceptual framework and precepts, or the unquestioned assumptions that shape the organizations beliefs, values, and operations, and provide meaning and direction for members' actions” (p. 14). Today the terms paradigm and paradigm shift are ubiquitous and have lost much of their original meanings. Levy and Merry mention the similarity of the term paradigm to other common terms at the time of their writing (shared meaning, world view, context, and conceptual framework to name a few).

Lowry (2002), in response to the emphasis libraries were placing on digital collections, indicated that the paradigm shift was occurring in the organization and delivery of information (scholarly information) — not in libraries. Libraries and the profession of librarianship had no



choice but to respond to and embrace this change in format and the technological advances of the time in an effort to maintain their institutional roles and to expand it; “the paths of IT development, scholarly information, and library transformation have merged, creating a complex interaction” (Lowry, 2002, p. ix)

In this investigation, efforts initiated by the study sites resulted in what can be characterized as a paradigm shift, as indicated by the comments in Table 6.6. Unlike the change described by Lowry (2002), many of the librarians felt they were breaking away from traditional library roles (sites B and D) and mentioned being involved in the research process at the beginning (sites A and B) as examples. This shift in mind set is what the library administrators were seeking and hoping for when they discussed the importance of getting involved in e-science and data management services.

### **Demand Increases**

As the change process progressed, the increase in demand surfaced as a tipping point<sup>3</sup> and required additional resources to be assigned to data management services, such as number of staff allocated and the percent of time being spent on data management projects. As news of the results of the libraries services spread, new researchers came forward for assistance, resulting in new partnerships being formed. The additional resources and new collaborations all validated the need for new thinking about the role of the library on campus; the paradigm shift took hold (see Figure 6.1).

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<sup>3</sup> Gladwell defines a tipping point as “the moment of critical mass, the threshold, the boiling point” (2000, p. 12).

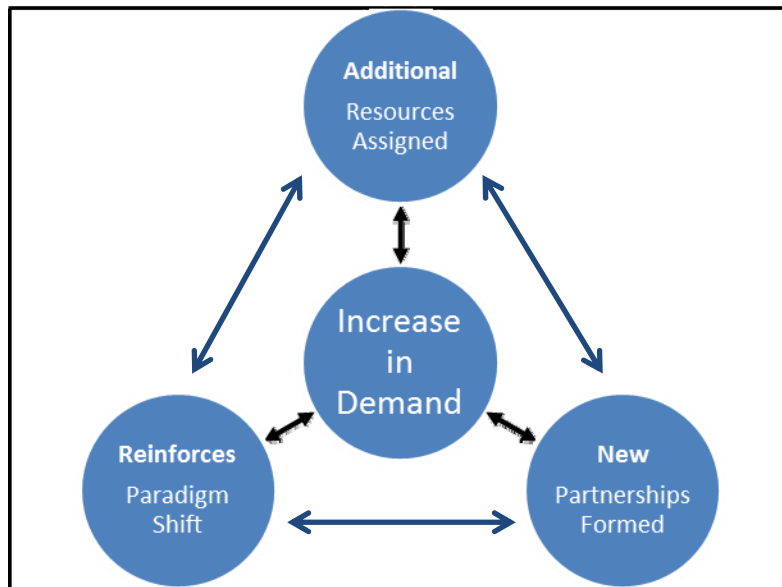
Table 6.6

*Comments to Support Process to Bring About Changes: Paradigm Shift*

Process	Interview Comments
Paradigm shift	<p>“It has been a real marked shift ... in the last three or four years, from thinking we are a digital library, where we are collecting this to getting much farther into the research process.” (Focus Group Participant, site A)</p> <p>“It feels different to me. I feel like we are moving into a different role. We are working with data earlier than when we were cataloging books or create metadata. ... But we are trying to work with data, or prepare people...to manage data before they have created it. We are earlier in the data life cycle when we are working with people to help them figure out how to manage it.” (Focus Group Participant, site B)</p> <p>“It’s not just, oh, we are helping professor x out and we are working with him for a year and then that dies and go on to something else. [It’s] how can we hang up a shingle and say, we do this and figure out the what the service components, and resources, and requirements are so that the libraries as a whole offers this particular service to researchers and students.” (Focus Group Participant, site C)</p> <p>“It is a different from traditional library services. It is even different from the more digitally-oriented library services such as digital repositories for documents or faculty publications. ... It is a new model from traditional librarianship, I would say.” (Focus Group Participant, site D)</p>

Figure 6.1

*Effects of the Increase in Demand*



In the case study libraries, demand is driven by users of the services the library is providing. Beyond the requirements of the granting organizations to provide access to the raw research data, word spread among the local research community about the work and services the library provides. A strategic partner at University C commented on the increase in workload the library had taken on:

They are part of an active brainstorming research group that has grown from an occasional idea or occasional proposal, to every time we write a proposal.

It has evolved from where I would go talk to them, “do you want to be involved?” to say, “okay, we are thinking of doing this, is your group interested, these are the pieces of text that I have.” It is a back and forth. Is this what you would still suggest to do? We have moved from a somewhat occasional, lower-grade effort to a much higher-grade, although still unfunded, collaborative effort to try and advance it.

Table 6.7 displays quotes from librarians at each site about the growth and demand for the libraries' services.

Table 6.7

*Comments to Support Process to Bring About Changes: Increase in Demand*

Process	Interview Comments
Increase in Demand	<p>"I think we've got lots of ideas, but we don't really have the manpower to do all of them." (Focus Group Participant, site A)</p> <p>"In the area we are looking at, very specific to how to deal with all the data and all the issues around the data generated by the research and how to appropriately handle that data and think about its life cycle management and so many different research groups have their own particular requirements and issues around it It's just a very complicated space." (Focus Group Participant, site B)</p> <p>"[The intention was] I would get grants that would fund my continued employment here. I think that we were more successful than we had anticipated." (Focus Group Participant, site C)</p> <p>"We find more and more people actually using it and more and more people just assuming its part of their research infrastructures." (Focus Group Participant, site D)</p>

### **Institutionalization of Change**

Often, the most difficult phase in managing change is when managerial leaders<sup>4</sup> work to sustain the momentum of the implementation (Kotter, 2005b). Change efforts can encounter a wide variety of obstacles, for example staff resistance to assuming a new role, change in key staff, or lack of resources. The libraries in the study experienced strong, visible, ongoing support from institutional administration. This was important as the libraries shifted into a new role. In

<sup>4</sup> Managerial leaders are defined as "leaders who are influencing others, creating visions for constructive change, and developing mutual purposes, while at the same, serving as managers involved in the effective planning, organizing, staffing and controlling of their organizations" (Lim, 2012, p. 154).

the libraries, those directly asked to support e-science through programs and services received ongoing support, including the provision of resources along with training and coaching.

Three of the study sites (A, C, and D) decided it was important to restructure the library organization so that specific staff could dedicate time to data management. Library administrators at site B, who described the library's involvement as a "grassroots effort" growing from the bottom up, decided it would be best to encourage all staff to get involved in data management and formed a cross-functional team structure in which people from various library departments could be involved. The comments in Table 6.8 make reference to the new departments and the range of skills needed to support the e-science and data management services.

Table 6.8

*Comments to Support Process to Bring About Changes: Institutionalization of Change*

Process	Interview Comments
New Department / New Staff	<p>"We just hired a life sciences data services librarian"; "...now [it] has been reorganized as a new unit ... to provide research support services." (Associate Director, site A)</p> <p>"Well, we've done something pretty bold, which we and others are watching. We decided to try putting together the units that had responsibility for network and computing based services. [They have] what it takes to support this work ..." (Library Director, site B)</p> <p>"I think another think that we did was recognize. There was a worker ... he had a very deep understanding of technology, about how to apply it ways that facilitate the things that we now call e-science. We made a structure change ..." (Library Director, site C)</p> <p>"We also have gone out and hired new staff." "Another thing that happened was the creation of this new unit." (Library Director, site D)</p>

The affirmation and other forms of support that library staff received helped to emphasize the importance of the new direction. Employee performance management systems were put in place. These included new job descriptions, individual goal setting, rewarding behaviors that successfully achieve goals and accomplish change, and addressing performance issues, especially among those who were slow or resistant to embrace the new direction of the library.

### **Case Study Change Process as a Model**

In order to evaluate the completeness of the case study change process, the investigator used two widely accepted tools. The first is the transtheoretical model (TTM) (also called the stages of change model), which was developed by Prochaska and DiClemente (Prochaska, 1984). Their framework evolved through studies comparing the experiences of smokers who quit on their own with those requiring further treatment. The purpose was to understand why some people were capable of quitting on their own and others were not. It was determined that people quit smoking if they were ready to do so. Thus, the TTM focuses on the decision making of the individual and is a model of intentional change. Different behavioral theories and change constructs can be applied to various stages of the model as needed.

The TTM operates on the supposition that people do not change behaviors rapidly and decisively. Rather, change in behavior, especially habitual behavior, occurs continuously through a cyclical process of pre-contemplation, contemplation, preparation, action, maintenance, and termination. The TTM framework for change has been applied in numerous situations related to organizational change efforts and the acceptance by employees of new roles (Boswell, 2011; Lyons, Swindler, & Offner, 2009; Matheny, 1998; Narayan, Steele-Johnson, Delgado, & Cole, 2007).

The investigator paired the TTM framework with the five process groups as originally defined by the Project Management Institute (PMI) in its standards guidelines, the Project Management Body of Knowledge (PMBOK), which guides the practice of project management worldwide. The life cycle of a project can be broken down into five distinct phases or process groups (Project Management Body of Knowledge, 2000):

1. Initiating, which defines and authorizes the project;
2. Planning, which refines the project objectives and then plans the steps necessary to achieve those objectives within the project scope;
3. Executing, in which people and other resources are combined with the project management plan to carry out, or execute, the plan for the project;
4. Monitoring and controlling, which checks the progress of the project and corrects problems; and
5. Closing, which formally closes each phase or the project and receives approval of the project work for the phase or project.

Using the TTM and the PMBOK to form a matrix it is possible to position the steps of the change process used by the case study libraries for comparison (see Figure 6.2). It is evident that the case study libraries addressed all the steps of the TTM stages of changes while following a similar process as outlined by the PMBOK, and that there is an emphasis on the initiating/pre-contemplation/contemplation phase as well as on the action phase.

Step five in the study process, paradigm shift, is placed in the maintenance/executing phase. The acquisition of a new outlook, attitude, and purpose constitutes the paradigm shift; this new view is a necessary part of embracing the process to execute and maintain the work. The

final stage of the identified study process is not termination or closing, rather, the goal is to institutionalize the paradigm shift as librarians assume the role of data manager and researcher.

Figure 6.2

*How the Study Process Fits as a Change Model*

PMI Process	TTM Stages of Change					
Groups	Precontemplation	Contemplation	Preparation	Action	Maintenance	Termination
Initiating	1. Identified need					
	2. Decision to act					
Planning			3. Resources Assigned			
Executing				4. Partnerships formed		
				5. Paradigm shift		
Monitoring and control				6. Demand increases		
Closing						7. Institutionalization of changes

**Change Process Comparison**

Despite some differences in the process models proposed by Judson (1991), Kanter et al. (1992), Kotter (1996a), and Luecke (2003) and that process model which was identified in this research as being used by the libraries in the study, there are remarkable similarities among them (see Table 6.9). It is interesting to note that while the models are not perfectly aligned, each model presents change in a related fashion, beginning with recognizing the need for a change to occur and ending with formalization of the change. The steps in between vary in scope and order, but all focus on elements of vision, communication, and assigning leadership and resources.

One noticeable feature in Table 6.9 is the order in which identifying a need for change and developing a vision occur. In the case of the libraries in the study (and as a first step in the change models with which the study process is compared) it was the identification of the need to make a change (to provide e-science programs and services) that came first. The need to make a

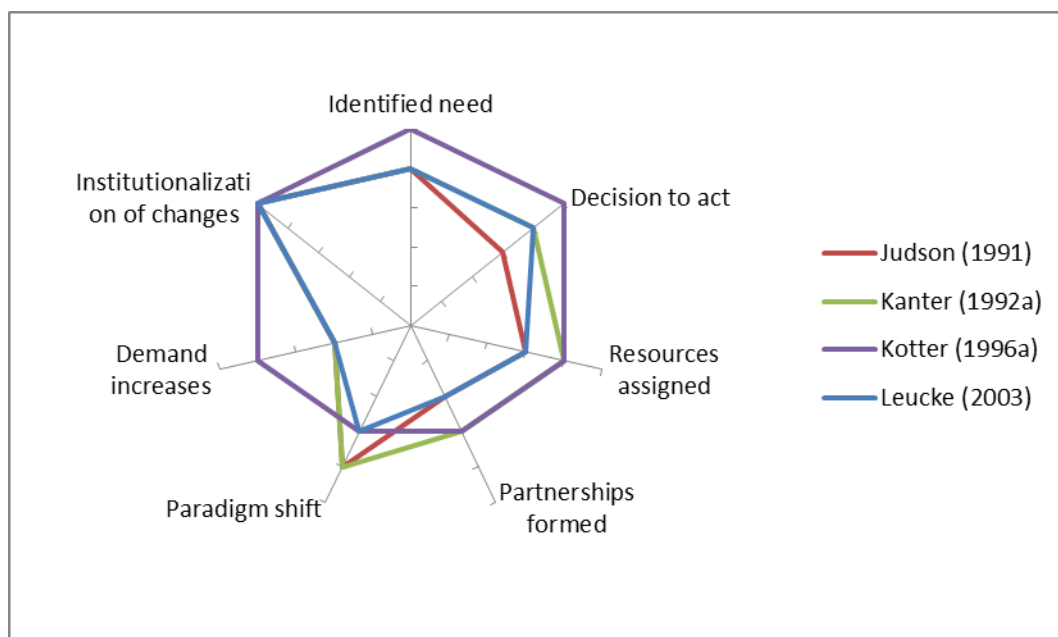


change in services and programs was based on both internal and external pressures, as identified in Chapter 5. It is after identifying the need to make a change that the libraries studied determined that the offering programs and services related to data management and e-science was in alignment with the libraries' mission and vision.

Figure 6.3 is a visual representation of the study steps and how Judson (1991), Kanter et al. (1992), Kotter (1996a), and Luecke (2003) compare. Kotter (1996a), although not aligned perfectly, offers the closest match to the process used by the study sites. One key difference between Kotter and the study process is the underlying paradigm shift that must occur for transformational change to occur. Kotter's (2006a) process is designed for a large-scale yet incremental change. (Kotter, 2012a) adds that his proposed model works best when it occurs in the prescribed order and in an organization that has a strict hierarchy; a paradigm shift will take longer to achieve in such environments.

Figure 6.3

*Overlap of Study Process with Established Models*



## **Conclusion**

Many theories have been developed regarding the design and running of organizations, and how to initiate change within them. One of the main characteristics of these theories is the attempt not only to prescribe what organizations should do, but also to set out how to go about change when faced by a specific set of circumstances. There is no one way to structure an organization in response to change. The tendency to replace choice with certainty does not just relate to the structuring of organizations; it is also a fundamental tenet in the organization change literature (Burnes, 1996).

Just as change comes in all shapes and sizes, so too do models of change. Therefore, rather than seeing one model as superior or more appropriate, it is better to view these approaches as applicable to different situational variables, such as organizational culture and the unique situation. Consequently, managing change is not about managers implementing the best practice laid down by the latest expert. Nor is it about automatically adopting an approach which matches a set of circumstances. Instead, it is about making choices appropriate to the current environment: choice in terms of what to change, choice in terms of the circumstances under which the change takes place, and choice in terms of the approach adopted.

Organizational transitions signal a break from the familiar: that is, they imply a major shift in an organization's character, nature, and functioning. In flux are values and ideals, structure, and ways of operating that have characterized the organization for some period of time. Familiar methods which have served as guides for providing services and programs become less relevant as new needs and processes come into existence. A different future is anticipated and the transition period unfolds more or less intentionally.

After close analysis of why the libraries became involved in e-science (Chapter 5) and the process by which the library became involved (Chapter 6), Chapter 7 addresses the question of what changed and whether it can be considered a transformational change (second-order change).

Table 6.9: *Change Processes Compared*

Judson (1991)	Kanter (1992a)	Kotter (1996a)	Luecke (2003)	Piorun (2013)
1. Analyze the change	1. Analyze the org and need for change		1. Mobilize energy and commitment through joint identification of problem	1. Identified need
	4. Create a sense of urgency	1. Establish sense of urgency		
	2. Create a vision	3. Develop a vision and strategy	2. Develop a shared vision	2. Decision to act
2. Communicate the change	9. Communicate, involve people, be honest	4. Communicate the vision		
	5. Support a strong leadership role		3. Identify leadership	3. Resources assigned
3. Gain acceptance of new behaviors	6. Line up political sponsorship	2. Create a guiding coalition	5. Start change at the periphery	4. Partnerships formed
	7. Craft an implementation plan 8. Develop enabling structures	5. Empower others to act		
4. Change from the status quo to desired state	3. Separate from the past			5. Paradigm shift
		6. Generate short term wins	4. Focus on results	6. Demand increases
5. Consolidate and institutionalize the new state	10. Reinforce and institutionalize	8. Anchoring new approach in the culture	6. Institutionalize success through formal policies, systems, structures	7. Institutionalization of changes
		7. Consolidate gains and produce more change	7. Monitor and adjust strategies in response to problems in the change process	

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## **Chapter 7**

### **THE NATURE OF CHANGE**

According to Neal (2001), “Higher education libraries are advancing away from the traditional or industrial age library; a model that is no longer viable” (p. 1). He goes on to argue that this metamorphosis requires a shift from incremental change to radical change. Kuhn and Hacking (2012) said “the transition from a paradigm in crisis to a new one from which a new tradition ... can emerge is far from a cumulative process” (p. 85).

Major corporations, on the other hand, undertake moderate organizational change at least once a year and major change every four or five years (Kotter & Schlesinger, 2008). This distinction between a moderate incremental change and a major radical change as it relates to libraries’ involvement with e-science is a focal point of this study. Organizational transformations deal with radical, fundamental, and total change in an organization, as opposed to advancing the organization in a few selected areas. Transformation is often associated with a situation in which an organization cannot continue to function and perform as it did before. In order to remain effective and relevant, there is a need for a profound change in every aspect of the organization, including mission, goals, structure, and culture. This type of change is referred to as second-order change or transformational change.

Levy and Merry (1986) provide the characteristics for first- and second-order change (see Table 2.2). These characteristics identify the nature of change and are discussed throughout this chapter in the context of the four case studies. In addition, Levy and Merry (1986) categorize the content of change: (1) organizational paradigm, (2) organizational mission and purpose, (3)

organizational culture, and (4) functional processes. This categorization is part of the discussion of the nature of change occurring in the libraries studied.

During the interviews and focus group interviews, participants in the case studies identified a number of changes that occurred at their institutions, ranging from assuming new duties to hiring new staff. Table 7.1 lists those changes (which have been classified by the investigator and to confirm reliability, nine other students from the Simmons College Managerial Leadership for the Information Professions Ph. D. program) as either a first- or second-order change, using the characteristics outlined by Levy and Merry (1986) in Table 2.2.

Table 7.1

*Identified Changes Categorized as First- or Second-Order Change*

	Site				
Changes	A	B	C	D	Order
Workflow changes	D		L		1 <sup>st</sup>
Gain new skills, new training, subject knowledge	L	L (2)	A, L		1 <sup>st</sup>
New position(s) created	L	L	A, L	L	1 <sup>st</sup>
Became embedded	L		L		1 <sup>st</sup>
Added responsibility / change in staff role	L	L	D	L	1 <sup>st</sup>
Emphasis on electronic	L				1 <sup>st</sup>
Reach new faculty members, students, administrators	L	L	D	L	1 <sup>st</sup>
Working with a changing product		L			1 <sup>st</sup>
Training website		L	L		1 <sup>st</sup>
Acquiring new collections (datasets)			L		1 <sup>st</sup>
New department, team, or workgroup	D, L	D, L	D, L	L	2 <sup>nd</sup>
Oversight structure	D, A, L	D, A, L	L		2 <sup>nd</sup>
New services	L	L	L	L	2 <sup>nd</sup>
New library role		L		L	2 <sup>nd</sup>

Key: D=Director; A = Associate Director; L= Librarian

### **First-Order Change: Examples from the Case Study**

First-order changes are incremental modifications that remain within the established structure or method of operating. Bess (2006) describes first-order change as “change without change” (p. 9). The implementation of a first-order change through strategic planning or other organizational actions might include restructuring or modifying current structures, roles, and processes to support a new initiative, but the organization’s core identity, as embodied through its values and mission, remains the same.

The first-order changes identified by the libraries, also referred to as functional processes by Levy and Merry (1986), are primarily related to the libraries’ structure, management, technology, decision-making processes, recognition/rewards systems, and communications patterns. Table 7.2 is a combination of the list of changes that have been categorized as first-order (Table 7.1) and the corresponding first-order characteristics identified by Levy and Merry (1986) (see Table 2.2). It is important to point out that all of the recorded changes in Table 7.2 are categorized as first-order change because they are quantifiable, logical, and rational, within the current view of the libraries’ roles, and continue along the same traditional way of thinking and being. These characteristics that were just mentioned (e.g., quantitative and logical) do not have any corresponding examples in Table 7.2 as these are concepts that when taken together further describe the other recorded changes. For example, reaching and connecting with new faculty members are acting within the old state of being, whereas changes in workflow are examples of logical and rational choices that fall in first-order change.

Table 7.2

*Recorded Changes with Corresponding First-Order Change Characteristic\**

<b>First-Order Change Characteristics*</b>	<b>Recorded Changes</b>
A change in one or a few dimensions, components, or aspects	Reaching and connecting with new faculty members, students, administrators
A change in one or a few levels (individual and group levels)	Gaining new skills, new training, subject knowledge Becoming embedded within a department / research team
Change in one or two behavioral aspects (attitudes, values)	Adding responsibilities / changes in librarian role
A quantitative change	
A change in content	Emphasis on electronic over print Working with a changing product (as data moves through the research life cycle)
Continuity, improvements, and development in the same direction	Workflow changes Acquiring new collections (datasets) Training website created for patrons and staff
Incremental changes	New position(s) created related to data management
Logical and rational	
Does not change the world view, the paradigm	
Within the old state of being (thinking and acting)	

\* Adopted from the work of Levy and Merry (1986).

### **A Change in One or a Few Dimensions, Components, or Aspects**

A second-order change consists of multiple changes in multiple areas, whereas a first-order change is more focused and centralized. Reaching and connecting with new faculty members, students, and administrators are considered first-order changes as these activities are consistent with the more traditional aspects of academic librarianship. Librarians provide a wide range of services to faculty and researchers, such as consulting with them to discuss strategies to

support instructional needs and offering seminars to them on the library's resources (Yang, 2000). According to Kozel-Gains and Stoddart (2009),

A good liaison is a jack-of-all-trades incorporating people skills, designing Web pages, aiding faculty research, writing department or course-specific resource guides, providing face-to-face consultation, and informing and facilitating faculty in learning about new and emerging information technologies, such as those associated with Library/Web 2.0. (p. 131)

In a recent study, Peters and Dryden (2011), writing about the University of Houston Library's involvement in research data management, found that one "interesting consequence" (p. 398) of becoming involved in data management was the development of unanticipated partnerships forming between the science librarian and researchers in departments with which the librarian previously had little interaction. This experience was categorized as an "outreach opportunity" (p. 398). The participants described their opportunity to form new relationships as exciting and interesting but also in line with their everyday work and not a major change; the focus of the new relationships is based on the data needs of the researcher but is still viewed as being a part of traditional services.

### **A Change in One or a Few Levels (Individual and Group)**

Similarly, the impact of a first-order change is limited to one or a few individuals and even, perhaps, a small group whereas a second-order change affects an entire organization. For example one sentiment heard during the interviews and focus group interviews at each institution visited was the need for individual librarians to gain new skills, seek out specialized training opportunities, improve their knowledge of the research projects on campus, and improve subject knowledge so they could communicate better with the research teams.

Data management is an emerging area for librarians. The goal is to manage data so that they may be easily available to other researchers. This may require librarians to enhance more traditional library skills such as cataloging and description, as well as to develop search procedures for large datasets and explore ways to merge sets in a meaningful way (Creamer et al., 2012). Gold (2010), in support of establishing training programs, advocates for establishing the “legitimacy of library roles in data curation through formal education and training as well as by integrating data curation into existing library services” (p. 23).

A second example of identified change falling under this category is when individual librarians seek to become embedded within a department or a research team. At the time of the site visits, few librarians were succeeding in this area, but not for lack of effort or desire. Library administration made it clear that this was an important milestone, and librarians were working towards it; however, it is a difficult transition from traditional liaison librarian to embedded librarian. According to Carlson and Kneale (2011), there are a lack of established approaches or paths to draw from when making this transition. They offer some basic advice such as gaining institutional support, being a team player, thinking like an entrepreneur, accepting risk, and moving outside of the established comfort zone. These types of suggestions confirm the placement of this activity as a first-order change; no significant change in thinking or acting is required to move into an embedded role.

### **Continuity, Improvements, and Development in the Same Direction**

Business process improvement, also called functional process improvement, involves perfecting the quality, productivity, and response time of a business process, by removing any non-value adding activities and costs through incremental enhancements (Harrington, 2007). Examination of processes is a first-order change as it seeks to improve the path already chosen,



as opposed to developing a new direction. Workflow changes described during the site visits fall into this process improvement category, and are first-order changes. One example of change included developing a workflow for requests for data services that came via the reference desk or through a liaison who did not feel adequately trained to work independently on a data management project. Another example is developing a referral service or process to involve a metadata specialist in a new project. The development and expansion of the institutional repository (IR) are another example. Site participants spoke about the limitations of their current IR system and how they needed to work with the staff managing the IR and vendors to determine when it was an appropriate resource for a data management project, and in which ways it could be utilized.

One example that falls into the business process improvement category is the development of a training website on data management designed primarily for graduate students, faculty, and researchers. It is not new for the library to create a specialized website for educational purposes on a relevant topic. The creation of the data management website is seen as applying a tried and effective method of reaching library users with the latest topic of interest. The librarians also identified this as an important tool for the learning process and for understanding the importance of e-science and data management.

During the site visits, the researcher specifically asked how the growth of e-science at the institution has affected collection development activities. Participants at each location indicated that they were purchasing datasets as requested, but they also indicated that they felt this was in line with past practices and simply an update in format.

## **Incremental Changes**

One of the key signs that the changes occurring are first-order is the incremental process through which the changes come about. Incremental changes are small adjustments made toward an end result. In an organization, making an incremental change to the manner in which things are accomplished typically does not threaten to modify existing power structures or alter current methods in any significant way. Williams (2011) believes that when a business makes only incremental changes, it will find itself on a path that gets narrower and narrower. Eventually, when the business reaches the end of the path it will be forced to go in a new direction.

The librarians in the study identified the creation of new data librarian positions as an incremental change in that the library only hired one or two librarians at a time. They commented on the fact that the education and background of many of the new employees differed from their own. The administrators viewed the hiring of one or two data librarians as a first step: vacant positions were funneled into the data management support program, or at a minimum the positions were updated to include data management duties.

## **A Change in Content**

Two changes in content (materials and skills used) have occurred since the libraries started providing e-science and data management services. The first, the emphasis on electronic over print resources, is not directly related to e-science. Many subject specialists and librarians working at the graduate and undergraduate level have reported the growth and dependence of researchers on electronic resources (Fry & Talja, 2004; Groote & Dorsch, 2001; Tomney & Burton, 1998). However, in this instance, the librarians' comments also refer to the type of materials that the researchers need help managing. In the past, a librarian working with a researcher might be asked to assist in managing paper records. Today, researchers are producing

data in many different digital file formats: few paper-based records are associated with the projects.

The second noteworthy change regarding content is the fact that librarians have come to view themselves as working with a changing product; as the data move through the research data life cycle it undergoes transformation. Often there are multiple formats and versions of the same data. The librarians saw this as something they were capable of managing; it was something new, but not so different.

### **Second-Order Change**

Levy and Merry (1986), who identified four perspectives of second-order change, examine the content of change based on four dimensions: organizational paradigm, organizational mission and purpose, organizational culture, and functional processes. In addition to these dimensions, they also comment on what elements have changed and the visibility to the organization's members of the existence and function of these elements. Table 7.3 summarizes the four perspectives and classifies them according to the organization's elements and dimensions that are changed, and the visibility to the organization's members of the existence and function of these elements. Levy and Merry (1986) assert that first-order change or changes in process are easily noticeable and concrete in nature. The examples mentioned of first-order change were all functional in nature, easily recognizable to outsiders, and tangible; for example, the training website mentioned above meets all these criteria.

Table 7.3

*The Content of Second-Order Change\**

<i>Perspective</i>	<i>Change Elements</i>	<i>Change Dimension</i>	<i>Visibility</i>
Evolutionary theory <sup>1</sup>	Context, template, metarules, world view	Paradigm	Unnoticed
Management theory	Goals, reasons for existence, policies, strategies	Core mission and purpose	Low
Planned change <sup>2</sup>	Norms, values, beliefs	Culture	Medium
Systems theory <sup>3</sup>	Inputs, outputs, throughputs, processes	Functioning process	High

\*Source: *Organizational Transformation: Approaches, Strategies, Theories* by Amir Levy and Uri Merry. Copyright ©1986 by Preager Publishers. Permission from ABC-CLIO, Santa Barbara, CA.

<sup>1</sup> Evolutionary theory in relation to the dynamics of institutional change refers to a set of specified activities (mechanisms of transmissible variation) which generate changes (transmittable differences), and a mechanism of selection which determines the relative success with which these differences propagate (Farrell & Shalizi, n.d.).

<sup>2</sup> Planned change is a set of activities in an organization that are intentional and goal-oriented with the purpose of bringing about a different future.

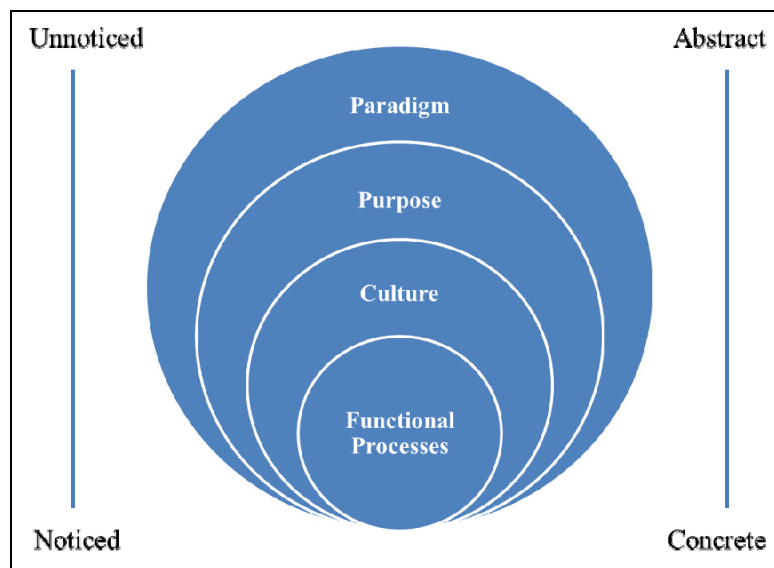
<sup>3</sup> Systems theory is a method of formal analysis in which the object of study is viewed as consisting of a series of distinct but interconnected components or subsystems. The concept was brought into the social sciences in the 1960s as a means of investigating social complexity and long-term change.

The change dimensions represented in Figure 7.1, as a nested set, intersect and overlap with each other in some instances; however, each dimension is embedded in, and formed by the higher levels (Levy & Merry, 1986). This suggests that changing the organizational paradigm or world view automatically necessitates changes in the following dimensions: organizational mission and purpose, culture, and functional processes. Changes in the organizational mission and purpose require changes in culture and functional processes, but not necessarily in the organizational paradigm. Hence, change in the organization's culture causes change in the

organization's functional processes, but not necessarily in its mission and organizational paradigm (Levy & Merry, 1986).

Figure 7.1

*Change Dimensions*



Source: *Organizational Transformation: Approaches, Strategies, Theories* by Amir Levy and Uri Merry. Copyright ©1986 by Preager Publishers. Permission from ABC-CLIO, Santa Barbara, CA.

**Examples of Second-Order Change from the Case Studies**

Levy and Merry (1986) view second-order change (or transformation) as a change that occurs in all four dimensions: from the core, functional processes, through mission and purpose, culture, and finally the organization's world view. In the case studies, functional processes (or first-order change) occurred. The remaining changes (see Table 7.4) have been categorized as second-order change and fall into two of the dimensions identified by Levy and Merry (1986), mission and purpose, and culture; these are discussed in further detail below.

Table 7.4

*Recorded Changes with Corresponding Second-Order Change Dimensions*

Changes	Site				Dimension
	A	B	C	D	
New services	L	L	L	L	Mission and Purpose
New library role		L		L	Mission and Purpose
New department, team, or workgroup	D, L	D, L	D, L	L	Organizational Culture
Oversight structure	D, A, L	D, A, L	L		Organizational Culture

Key: D=Director; A = Associate Director; L= Librarian

**Organizational Mission and Purpose**

Having a clear and concise mission statement to follow is essential for success. A change in mission is categorized as a second-order change because it involves core questions related to what business the organization in and what the strategies are for achieving the organizational mission, goals, and policies. There is an explicit stated program of action to move forward. The mission statement addresses what the organization is about, what it does, whom it serves, and to what end (Pearce & David, 1987).

During most of the twentieth century, academic libraries were characterized by activities that built similar collections of physical materials and by systems of access and services that mediated between individuals and content to serve the expressed information needs of library users (Kaufman, 2005). The library building is a prominent iconic representation of status within the university: centrally located, critically important, large, separate, and distinct. Historically, it served all disciplines, not only with similar tools but in similar ways (Kaufman, 2005).

When data management and e-science were introduced, library administrators saw these activities as new and a need that was waiting to be filled, yet within the framework of the library's current mission. For the libraries in the study, the blueprint for providing e-science support and services was laid out in the libraries' strategic planning documents. It is there that the plan for new services and for transitioning into a new role in data management was first outlined and shared with the library organization.

### **Organizational Culture**

According to Kotter (2012b), organizational culture consists of group norms of behavior and the underlying shared values that help keep those norms in place. It also deals with symbolic action and elements such as myths, rituals, ceremonies, the look and arrangement of the physical setting, and the style of management and relationships. In order to change culture, according to Kotter (2012b), a person in authority maintains the old ways are not working. As a result, a new vision is developed; individuals and groups start acting differently and enlist others to also act differently. If the new actions produce better results and if those results are communicated and celebrated, new norms form and new shared values grow.

Two changes identified in the study sites fall into the category of organization culture: (1) a new department/team/workgroup was formed to manage data management requests, and (2) a new oversight structure was put in place to manage the new department/team/workgroup. Restructuring and creating a new department are not unusual in libraries. The study sites restructured specifically to take on new work and provide new services; it was not a matter of taking an existing group and changing the reporting structure for that group. At study sites A, C, and D new departments were formed with new reporting lines either directly to the director or to

an associate director. At site B, where the team approach was used, the associate director was assigned to the team and helped to direct the work of the team.

Changing an entrenched culture is a difficult task. Kim and Mauborgne (2005) identify four hurdles that a managerial leader must face when trying to institute broad cultural change in an organization. The first is cognitive; people must have some understanding of why the change in culture is needed. The second is limited resources; inevitably, changing an organization requires shifting resources away from some areas and towards others. The third hurdle is motivation; ultimately, workers have to want to make the change. And, the final hurdle is institutional politics; whether or not the organization's administration is open to new ideas and new opportunities, and to working together to determine the best roles for all stakeholders to assume.

To overcome those hurdles, Kim and Mauborgne (2005) suggest a "tipping point" approach to management. First, they suggest the importance of recognizing that not everyone will embrace the new culture from the start. They suggest beginning with people who have influence in the organization, encouraging their commitment to the change, and once they are committed to change, shining a spotlight on their accomplishments so others hear the message that change is celebrated. Second, instead of lecturing on the need for change, they recommend looking for ways in which people will connect current experiences with the need to make change. Third, Kim and Mauborgne (2005) identify opportunities to redistribute resources toward activities that require few resources but result in large change, and away from areas with large resource demands but likely to experience relatively low impact. By following this approach, when library administration sets aside dedicated staff resources and time to work



formally on data management, a clear message can be sent to all internal and external to the library that a culture change is occurring.

### Experience of Change

The investigator asked the library administrators and librarians working on e-science and data management if they thought the changes occurring were first- or second-order change, substituting the word “evolutionary” for first-order change and “transformative” for second-order change (see Table 7.5). The majority (14 of 20) of them indicated that they thought the changes were evolutionary in nature. This is indicated by phrases such as “rapid little steps,” “hurry up and wait,” and the sentiment that the library was reacting to external forces: truly transformational changes were occurring outside of the library.

Table 7.5

#### *Experience of Change as Evolutionary or Transformative*

<b>Response</b>	<b>Site</b>			
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Evolutionary	D, A, L (2)	L	D, A, L (5)	D, A
Evolutionary but feels transformative	L			
Blend		D, L (3)	L	L

Key: D=Director; A=Associate Director; L= Librarian

Six of the study participants indicated there was an element of the transformative present:

- “The ideas are a revolutionary way to think of librarianship.”
- “If we had more time to dedicate to the projects it could be revolutionary.”
- “Part of the constraints on how transformational it is for us is the resource constraints that we are under.”
- “I think for the library at large, it is revolutionary. I would share that my manager looks at it and says this is the future of libraries. It is quite revolutionary. It really

shakes the fundamentals of what libraries do but we are just at the early stages of it. It has great potential.”

In the context of commenting on the question relating to the order of change, the participants provided a list of changes they were experiencing. The results are listed in Table 7.6 and classified by their change dimensions. Five of the changes experienced are categorized as first-order change or relating to functional process. These include issues related to learning new skills and making new contacts, and some of the frustrations associated with having to deal with new performance expectations. The comments associated with experiencing a new organizational culture refer to hearing a message that e-science is important, that there are internal movements supporting the new direction, and that there is a period of adjustment and an element of self-motivation required.

As the experiences become more abstract in nature, there are fewer listed (functional process, 5; organizational cultural, 5; mission and purpose, 2; and paradigm, 1). Among librarians who participated in the focus group interviews at sites A and C there was a sense that the library was moving into a new area (e-science and data management), and a strong belief that the libraries had a role and valuable experience to contribute. As a result, the primary purpose of the library needed to shift from being a collector of content to a service provider and collaborator.

Table 7.6

*Experience of Change with Dimension*

	<b>Site</b>					
<b>Experience of Change</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>Order</b>	<b>Dimension</b>
New attitude/view	A		L		2 <sup>nd</sup>	Paradigm
New way of thinking/acting	L	L	L	L	2 <sup>nd</sup>	Paradigm
New area	L		L		2 <sup>nd</sup>	Mission/Purpose
Focus on services not content	L		L		2 <sup>nd</sup>	Mission/Purpose
Adjustment period		L			2 <sup>nd</sup>	Organizational Culture
Consistent message – e-science is important		L	L		2 <sup>nd</sup>	Organizational Culture
Grassroots effort		L			2 <sup>nd</sup>	Organizational Culture
Outside / faculty resistance			L	L	2 <sup>nd</sup>	Organizational Culture
Requires self-education	L		L		2 <sup>nd</sup>	Organizational Culture
Difficult to meet expectations early on				L	1 <sup>st</sup>	Functional Process
Formalization of what was already being done		L			1 <sup>st</sup>	Functional Process
Large learning curve			L		1 <sup>st</sup>	Functional Process
Limited opportunities for success			L		1 <sup>st</sup>	Functional Process
Opportunity to form new relationship			L		1 <sup>st</sup>	Functional Process

Key: A= Associate Director; L= Librarian

**Paradigm Shift in Second-Order Change**

The organizational paradigm, as already noted, is the “metarules,” presuppositions or underlying assumptions that discretely form perceptions, procedures, and behaviors. Levy and Merry (1986) propose that the organizational paradigm provides the context and logic for the organization’s culture, purpose, and operations. As a result, every change in the paradigm

necessitates changes in the other three dimensions: organizational culture, mission and purpose, and processes. Levy and Merry (1986) also propose that a change in any one of these other dimensions (e.g., culture) may, but does not automatically, cause changes in the other dimensions. Functional processes may change because of a new technology or new procedures, but this will not necessarily trigger changes in the other dimensions. They suggested, therefore, that the less visible the dimension experiencing change is the deeper the change and possibly the greater the likelihood the change becomes permanent.

Librarians at study sites A and C specifically mentioned that a new attitude and outlook were an integral part of the change experience occurring in their library environment. All four sites commented that the shift to supporting data management and e-science required a new way of thinking and acting. Using the conditions identified by Levy and Merry (1986) for second-order change, the organization and placement of the changes identified in the case studies suggest that the four case studies experienced second-order changes, having undergone changes in all four dimensions (see Table 7.7).

Table 7.7

*Number of Changes Occurring by Dimension*

	Site					
Dimension	A	B	C	D	Abstract	Invisible
Paradigm	2	1	2	1	↕	↕
Mission and purpose	3	2	3	2		
Culture	2	5	5	2		
Functional processes	7	6	12	4	Concrete	Visible

### Future Changes as First- or Second-Order Change

Each of the library administrators interviewed identified changes they thought would be implemented in the next three years (see Table 7.8). All of the planned changes fall into the

sphere of first-order change. The focus of these changes is to continue to grow and train staff for the changing work, to identify and developing success measures, and to monitor the local and national environment. The library director from site D specifically mentioned the importance of monitoring change in national politics, funding requirements, and the national research agenda. Other pending changes focus on administrative aspects, such as managing facilities, obtaining funding, and re-writing job descriptions. It is not unusual to expect that the library administration has a list of first-order change tasks to continue to monitor and follow through on. Any organizational change, first- or second-order, requires additional adjustments to ensure that the changes fit within the environment. The associate library director at site D specifically mentioned new data-intensive initiatives that would be forthcoming from the university administration, and that the library would need to make an effort to be part of these.

Table 7.8

*Future Changes with Dimension*

	Site					
<b>Future Changes</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>Order</b>	<b>Dimension</b>
Develop/identify success measures	D				1 <sup>st</sup>	Functional Process
Monitoring/environmental scan		D		D, A	1 <sup>st</sup>	Functional Process
Combining libraries			A		1 <sup>st</sup>	Functional Process
Re-writing job descriptions			A	A	1 <sup>st</sup>	Functional Process
Train staff for new work			A		1 <sup>st</sup>	Functional Process
Monitor national politics				D	1 <sup>st</sup>	Functional Process
New facilities				D	1 <sup>st</sup>	Functional Process
Obtain additional funding				D	1 <sup>st</sup>	Functional Process
New university initiatives				A	1 <sup>st</sup>	Functional Process

Key: D=Director; A=Associate Director

## **Conclusion**

The three questions used for understanding the order of change (the forces identified in Chapter 5, the process discussed in Chapter 6, and the content considered in this chapter), are placed in the integrated model developed for second-order change by Levy and Merry (1986) using the study findings (see Figure 7.2). Their integrated model is based on an open-systems theory, which identifies organizational behavior by mapping the repeated cycles of inputs, throughputs, outputs, and feedback between an organization and its external environment. Systems receive input from the environment either as information or in the form of resources. The systems then process the input internally, which is called throughput, and release outputs into the environment in an attempt to restore stability to the environment. The system then seeks feedback to determine if the output was effective in restoring the desired long-term and short-term goals (Bertalanffy, 1950; Katz & Kahn, 1978).

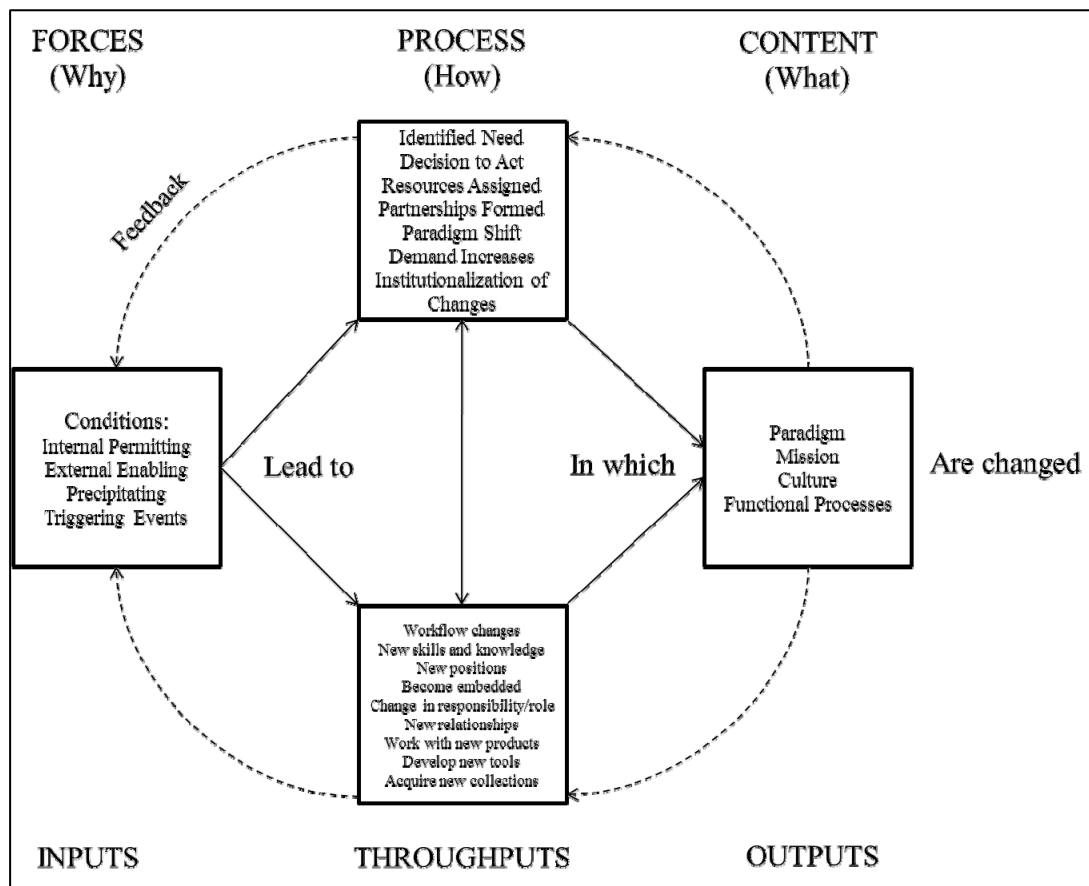
Using this model, the libraries that participated in the study could identify clearly some of the forces for change in their environment, such as the NSF data management requirement or researchers coming to the library and asking for help managing data, as a triggering event. These types of triggering events lead to a common process that was used to respond to stakeholder needs, resulting in similar throughputs such as new positions, new workflows, and partnerships. These many modifications may lead to a change in organizational culture, mission and, ultimately, a new view of library services; that is, a transformational change.

Transformational change is defined as those periods in an organization's life cycle when there is a major shift in the overarching paradigm that guides the organization. This type of change is possible when there are certain external and internal conditions, and in the light of pre-existing conditions some triggering event occurs. The ultimate goal is to change the underlying

assumptions and world view: the organizational paradigm. Library administrators who want to facilitate second-order change should focus efforts on changing underlying assumptions, beliefs, and behaviors. The four study sites were able to achieve this organizational transition. Chapter 8 indicates how this transition was led.

Figure 7.2

*Integrated Model for Understanding Second-Order Change\**



\*Adopted from the work of Levy and Merry (1986).

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## **Chapter 8**

### **THE ROLE OF LEADERSHIP IN THE MOVE TO E-SCIENCE**

Researchers have conflicting views about the cause of change in organizations (Fernandez & Rainey, 2006). Despite these divergences, a large body of research indicates that leaders frequently make change happen in their organization (Fernandez & Rainey, 2006). Leaders serve as the main role models for change and provide the motivation and communication to change efforts moving forward. Change does not happen easily; good leaders throughout the organization can facilitate change and help their organizations adapt to external threats and new opportunities.

The emphasis of this chapter is on leading second-order, or transformational, change. It is important to distinguish between leading transformational change and the theory of transformational leadership, since these concepts share common vocabulary but are not interchangeable. Transformational change, as defined in Chapter 2, involves not only moving the organization forward, but also transforming the core of the organization and how the organization views its place in relationship to other organizations. Transformational change is “multidimensional, multi-level, qualitative, discontinuous, radical organizational change involving a paradigmatic shift” (Levy & Merry, 1986, p. 5). Leadership focuses on the organization as a whole and the process of bringing about a new future. Transformational leadership, on the other hand, is “a process that changes and transforms people. It is concerned with emotions, values, ethics, standards, and long-term goals” (Northouse, 2013, p. 185). With transformational leadership the emphasis is on the individual follower (Bass, 1985) and

“assessing followers’ motives, satisfying their needs, and treating them as full human beings” (Northouse, 2013, p. 185).

Typically, when leaders launch change efforts, at least 70 percent of those efforts end in failure, and only 5 percent of change efforts achieve all of their stated objectives (Kotter, 2013). One of the primary reasons for this low rate of success is a failure to create the necessary groundswell of support among employees (Gilbert, n.d.). The ability to lead transformational change is often a key factor in the long-term success of an organization. Kouzes and Posner (2007) affirmed the link between leadership and generating change when they said, “Leadership is inextricably connected with the process of innovation, of bringing new ideas, methods, or solutions into use” (p. 165). During an interview, Peter Senge noted that the simplest definition of leadership is the ability to produce positive change (Webber, 1999). Similarly, Kanter (1983) stated, “Change requires leadership ... a ‘prime mover’ to push for implementation of strategic decisions” (p. 125). Although there are many reasons for which change initiatives fail, a primary solution is to create better change leadership (Daft & Lane, 2005).

In 1990, Kotter proposed that leading change required establishing direction, aligning people, and motivation and inspiration. Reardon et al. (1998) added two additional stages, described by (Kotter, 1990, 2012a) but not formally stated in his change model: launching and maintaining. Table 8.1 outlines these components and identifies the relevant focus areas within each component.

Reardon et al. (1998) argued that the formal inclusion of these two stages is critical to understanding leadership in transformational change, indicating that incremental changes may not require a formal launch or kick-off marking the change; “Radical change; however, demands that people depart drastically from the *status quo* and often that they do so in a limited time.

Launching takes the place of introducing change in dribs and drabs” (p. 133). The framework for examining leadership in the four case studies is the three-change leadership components identified by Kotter (1990) and the additional two elements added by Reardon et al. (1998).

Table 8.1

*Leading Transformational Change\**

<b>Component</b>	<b>Focus</b>
Establishing direction	Creating a change vision
	Clarifying the big picture
	Setting strategies
Aligning people	Communicating goals
	Seeking commitment
	Building teams and coalitions
Launching	Implementing change
	Getting results
	Assessing progress
Motivating and inspiring	Inspiring and energizing
	Empowering subordinates
Maintaining	Developing a learning organization

\* (Kotter, 1990, 2011a); Reardon et al. (1998); Senge (1990)

### **Establishing Direction**

The chief function of leadership is to produce positive change (Kotter, 1990). The direction of that change is at the core of what leadership is all about: setting direction and ensuring that change is carried out effectively. The direction-setting aspect of leadership creates

vision and strategies. The emergence of e-science has provided library leaders with a wide array of complex and rapidly changing information regarding their local environment and the data management needs of researchers. In response, library leaders in the study challenged the traditional roles of the university research library by experimenting with new services and programs (see Chapter 4 for a description of such services). Establishing a clear direction early, especially in the case of non-incremental change, helps to produce useful change by pointing out where a group should move, showing how it can get there, and then providing a message that is potentially motivating and uplifting.

### **Creating a Vision for Change**

Kotter (2011b) identifies two types of vision. The first is an overarching vision for an organization. In these instances, vision is an attractive view of the future that is credible yet not readily attainable. It links the present to the future, energizes people, and garners commitment; vision gives meaning to work and establishes a standard of excellence and integrity (Daft & Lane, 2005). When the investigator asked the case-study library leaders to define leadership, 7 of the 10 responses stated that having a vision was an important element (see Table 8.2). Having a vision can help the organization achieve bold change. By attempting to bring about a transformational change, leaders typically articulate visions that present a highly optimistic view of the future and express high confidence that a better future can be realized (Berson, Shamir, Avolio, & Popper, 2001). Kotter (2011b) proposes a second type of vision; he refers to this as a change vision. A change vision is not the same as an overarching corporate vision; “A generic corporate vision is ... [what] you think you need to look like out there on some fundamental dimensions to make you prosper” (Kotter, 2011b, para. 6).

Table 8.2

*Leadership Comments Related to Vision*

Site	Comments
A	"The key is having a shared vision."
B	"Part of leadership is staying plugged in and creating a vision that helps the library fit in."
C	"I would define leadership as having a vision." "Leadership is having a vision and finding a way to persuade people to come along with it." "It is having a vision and being able to articulate it."
D	"I think the leader needs to be able to focus on the vision in a very deep and substantive way." "Leaders need to be able to not only focus on the vision but track how supporting the vision is changing."

A change vision is a picture of what the organization will look like after significant changes are achieved, and it outlines the opportunities the organization will take advantage of once change is realized. The change vision serves as a motivator to do something that may not necessarily be in an individual's short-term self-interest. During a period of organizational change employees are often asked to work outside of their comfort zones, function with fewer resources, and learn new skills. In these situations the change vision motivates staff to overcome the initial reluctance to try something new. According to Kotter (2011b), a change vision is an essential aspect of any transformational change an organization is undertaking. Table 8.3 summarizes the responses the investigator received when she asked library leaders to articulate how e-science fits within the overall library's vision.

Table 8.3

*How E-Science Fits with the Library's Vision*

Site	How E-Science fits with the Library Vision (Paraphrased)
A	To advance and support the work of the faculty and students of the campus. E-science is part of that. To do this well requires collaboration with others on campus. Those collaborations are the most successful when all the parties are viewed as having something equal to contribute. The library is viewed as an equal partner in providing the necessary services.
B	To help support the university by developing systems and services that deal with how it can best disseminate out and preserve the knowledge that is generated. Data ... [are] the latest manifestation of that.
C	Support researchers across the research life cycle, keeping in mind the whole realm of scholarly communications, information literacy, and include all the things that the library has always been doing downstream with tertiary resources, collecting journals, monographs, archives, and digital objects to further support those in the labs.
D	Take advantage of new opportunities, form new partnerships, systematically build new infrastructure to support long-term data preservation by addressing fundamental questions both from a theoretical, policy, and practical perspective. Scientific datasets are the new form of collection development; a very special type of collection. Ultimately, we need to see in the next incarnation of libraries, that we think of data as the collection.

The library administration at all four sites, being aware of an institution-wide need to respond to data management needs, inventoried the available library resources, created a deliberate plan to engage the library personnel, and participated with other institutional stakeholders to formulate a change vision for the libraries' involvement. The administrators of the libraries studied had an opportunity to rejuvenate the library, they had a clear direction in which they wanted to move, and they engaged in a coordinated effort to bring about the change.

### **Clarifying the Big Picture**

After developing a plan for change, managerial leaders share that plan with others and help them internalize the importance and purpose of the change so that everyone works from the same starting point. The change effort becomes a common thread connecting people, involving them personally and emotionally in the organization (Daft & Lane, 2005). Leaders know how to



create the framework through which teams view the pending changes, allowing them to interpret even the most difficult changes in constructive, empowering ways. The contextual lens the leader creates is often focused on a desired outcome. Setting the context helps the organization understand how the pending changes relate to the large vision. It helps everyone who is affected by the change to envision the ultimate goal and then challenges them to build strategies to realize the change regardless of current obstacles (Maddock, 2012). In this study those strategies include identifying researchers' needs for data management and the libraries' strengths and weaknesses in this area. It also involves monitoring trends and being aware of pending challenges and opportunities. The libraries studied were able to set the context in three ways by: (1) assessing the current environment, (2) exploring the future, and (3) identifying the strategic issues.

**Assessing the current environment.** Assessing the current environment includes vetting the key assumptions that drive the strategic thinking, planning, and implementation process. Tools traditionally used to conduct this type of assessment include a PESTLE<sup>1</sup> or SWOT<sup>2</sup> analysis or an examination of Porter's Five Forces.<sup>3</sup> Commenting on the importance of being aware of the local context, the library director at site B stated:

I believe and I think we practice it here at [omitted name] libraries that the new environment into which libraries are moving is fundamentally and profoundly volatile. ... I think that libraries have to think about that

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<sup>1</sup> The PESTLE analysis is used to provide a context for the organization's/individual's role in relation to the external environment. It covers political, economic, social, technological, legal, and environmental factors. In some instances it can also include education and demographics (Baines, Fill, & Page, 2013).

<sup>2</sup> A SWOT analysis provides information that is helpful in matching the organization's resources and capabilities to the competitive environment in which it operates. Internal factors are classified as strengths (S) or weaknesses (W), and external factors are classified as opportunities (O) or threats (T) (Baines et al., 2013).

<sup>3</sup> Porter's Five Forces are: (1) threat of new entrants, (2) threat of substitute products or services, (3) bargaining power of customers (buyers), (4) bargaining power of suppliers, and (5) intensity of competitive rivalry (Porter, 2008).

technology, space, and services in terms of significant changes every two to three years if we are tracking them appropriately.

In a similar vein the director at site D commented: “I think people who are in jobs like I have now have to keep a broad outlook – we talk about environmental scans. It is a very large environment we are looking at.” This director specifically mentioned tracking issues such as U.S. government funding, legislation, and data sharing mandates such as from the NSF, as well as more local concerns related the formation of new university centers and institutes.

All the libraries studied indicated that they were responding to an emerging need in their local and national environments. One of the main triggering events described in Chapter 5 was the NIH and NSF data management requirements. This caused a real and pressing need among researchers, who did not know how to respond. At the institutional level, all study participants agreed that the library had an important role to play in developing local solutions to meet the needs of researchers who wanted assistance managing research data. For example, a representative from University B administration stated that the library has an important role in supporting e-science on campus. University administrators are looking to the library to provide updates on what is happening at other universities, to be a source of credible information, to be a unit that can bring different groups together, and to be a resource for developing and supporting new data management systems.

**Exploring the future.** Exploring the future involves identifying the general direction of change and then leveraging this knowledge for more effective strategic action and long-term success. There are many tools available to help leaders discern an ideal future, including

appreciative inquiry,<sup>4</sup> future mapping,<sup>5</sup> and scenario planning.<sup>6</sup> Although none of the participants mentioned these tools by name, the elements of appreciative inquiry were present. The leaders had a plan of an ideal service model and how the library would fit into that model. Each leader in his/her own way set out to make that future a reality by trying to (1) build on what worked in the past and incorporate the best into the future, (2) harness the power of imagination and dreaming, (3) create a blueprint for change that integrates the past and the future, and (4) move forward by matching resources with interests and abilities (Egan & Feyerherm, 2005).

**Identifying the strategic issues.** Every organization has strategic issues that need to be identified and considered when undergoing a transformation change. Analyzing these involves reviewing what was learned during the environmental scan and exploring the desired future, remembering the need to identify key challenges, opportunities, and the critical unknowns (Russell, n.d.). For the leaders studied, the primary issue identified was the need to support data management services across the institution.

Using three steps (assessing the environment, exploring the future, and identifying strategic issues) to clarify and communicate the changes can be challenging because library personnel may have different personal beliefs about what a library is and how best to serve library patrons. Some staff may be working from a different value set, placing importance on resources and services that are no longer needed and holding on to a very traditional view or

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<sup>4</sup> Appreciative inquiry is based on the premise that organizations change the direction in which they inquire. So an organization which searches for problems will keep finding problems, but an organization which attempts to appreciate what is best in itself will discover more and more that is good. It can then use these discoveries to build a new future where the best becomes the norm (Cooperrider, Whitney, & Stavros, 2003).

<sup>5</sup> Future mapping is a process for creating a vision, deciding how to achieve it and creating a motivation to act. It builds on the process of planning ahead but looks at this as if success has already been achieved. It can overcome blockages in thinking that can occur when trying to think ahead. It is a very creative, but fairly structured, process (van der Lugt & Munneke, 2007).

<sup>6</sup> Scenario planning is a technique with which participants develop a set of scenarios that eventuate in possible future outcomes. Not intended to circumscribe the future, it permits organizations and their staffs to help realize the future for the organization by reacting appropriately to change (Giesecke, 1998).

organizational paradigm of the library. These traditional views affect the thinking processes of those faced with a major change. Also, given their different professional experiences and general knowledge of the work and need of local researchers, coupled with the different levels of awareness of national trends and their potential implications, it is not surprising that the managerial leaders in the study used a variety of methods to communicate the need for and nature of pending changes. These methods included all-staff meetings, printed strategic plans, annual library updates, internal websites, and educational opportunities, and in some cases they served as resources for staff to refer to if needed.

### **Setting Strategies**

Strategic planning,<sup>7</sup> a successful management technique in libraries, provides a direction and framework for services and guides decision-making. It consists of goals and objectives. Goals are long-term aspirations that the organization intends to meet, while objectives are clear and sensible guides to action, clear enough to recommend particular types of actions, and are time-limited, feasible, and measureable (Hernon & Whitman, 2001). Objectives lead to the achievement of goals and should be “ambitious enough to be challenging” (Granger, 1964, p. 65)

Participating libraries used a strategic planning document to outline their goals and objectives for the library, which included e-science and data management programs and services. The sites varied with respect to the timeframe specified in their planning documents and the frequency with which the documents were reviewed and updated, as well as the level of detail specified in the documents. Yet, each library director brought up the importance of having a documented plan that could serve as a cornerstone on which to build the new programs and services. The library director at site C commented on the effectiveness of the strategic plan:

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<sup>7</sup> Strategic planning is defined as “a self-analysis or self-study that identifies the organization’s strengths and weaknesses and develops priorities within the framework of the organization’s physical and financial capabilities” (Childers & Van House, 1993, p. 18).

There is a critical mass now in the libraries that when I've had various visitors come to the libraries from outside ... and even outside the country, they come and they end up meeting with me at the end and they'll say, "Everyone is on board. We hear the same message consistently." So they understand it. It took us seven to eight years to do that because it was not a clear thing for us to do. But now when we hire people, I notice that search committees are much more likely to hire or recommend people to me who are consistent with our vision than they might have traditionally done. They seem to get it.

### **Aligning People**

Libraries have been working over the past decade to break down functional silos and look for cross-departmental collaborations to improve services (P. Miller, 2005; Wood, Miller, & Knapp, 2007; Zorich, Waibel, & Erway, 2008). As libraries in the study sought to improve customer services and develop new programs, the interdependence of library departments became evident. It is unusual for anyone to have complete autonomy in today's libraries; most employees are tied to one another by their work, technology management systems, and reporting structures (Kotter, 1996a). These relationships can pose unique challenges when the library attempts to change; "unless a large number of individuals line up and move together in the same direction, people will tend to fall all over one another" (Kotter, 1996a, p. 49).

Managers create systems that they can use to implement plans efficiently (Daft & Lane, 2005). This means getting people lined up behind a vision and a set of strategies so as to help produce the transformation needed to cope with a changing environment. The goal is to have everyone share a common understanding of a vision and set of strategies, accept the validity of

that direction, and be willing to work toward making it a reality. The potential result is making progress towards the vision.

### **Communicate Goals**

People are most easily aligned with a new direction when it is clearly communicated. Communication must occur as often as possible with all those people (staff, administrators, collaborators, and patrons) whose help or cooperation is needed. It is done whenever possible, with simple images, symbols, or metaphors that powerfully present the new vision (Giesecke, 2011).

The managerial leaders in the study found that leadership by example was an effective strategy in communicating the pending changes. It was their individual commitment and unswerving dedication to the change and implementation strategies that set the stage and communicated the importance of e-science and data services to the future of the library. On two different occasions librarians told the investigator how important it was that the director of the library was attending university meetings, identifying researchers' data issues, and setting up additional meeting to identify opportunities to help on an individual basis. The librarians were determined to meet the commitments the director had set. As well as actively promoting library services, having the directors stating the message that change is needed in a clear and practical way, and making sure their words and deeds were consistent (e.g., shifting resources and providing training opportunities), helped to convey the critical juncture the library faced.

### **Seek Commitment**

People commit to change because they gain something important from their involvement. When a leader invites them to become involved it is not solely about asking for or needing their help. In turn for their support, the individuals receive an opportunity to expand their skills, be a

part of a team, rise to a challenge, meet high standards, and accomplish something substantial. It is important for leaders to look for individuals with proven track records and/or enthusiasm to help carry out the change process.

Throughout the process of introducing e-science program and services, building commitment was slow. Library leaders worked with groups of individuals who were open to the idea and willing to learn and try something new. However, none of the leaders interviewed were willing to say that they had complete commitment from their staff. The library director at site C remarked: “I’m not saying if you spoke to every single person in the libraries that they would either understand this strategic goal that we have in data management or the vision that they would always agree with it.” Other directors spoke of staff who were hesitant to embrace the change and were more comfortable continuing to offer traditional services.

No director used staff resistance as an excuse to change direction or abandon the change process. They indicated that they would continue to encourage change in attitude and acceptance of training opportunities, but specified that there would be a time when acceptance would no longer be optional. As Kouzes and Posner (2007) note, disruptive change demands significant commitment and sacrifice, but the positive feelings associated with forward progress generate momentum that enables everyone to move forward.

### **Build Teams and Coalitions**

Leaders build coalitions and teams systematically and strategically. For the change process to succeed there must be a shared commitment to the possibilities of organizational transformation (Watkins, 2008). Kotter (2012a) concluded that the formal hierarchical structures and managerial processes present in today’s organizations are inherently risk-averse and resistant to change; “part of the problem is that all hierarchies, with their specialized units, rules, and

optimized processes, crave stability and default to doing what they already know how to do” (p. 48). As a solution to this problem, Kotter suggests the formation of a second network that is fluid and has the power to formulate and implement strategy continually; the network drives problem solving, collaboration, and creativity.

In the four case studies leaders choose the path of forming a new department or team. At each site a selected group of individuals were brought together to develop and implement an e-science strategy. These individuals were either aware of researchers’ needs, or expressed an interest, or had a natural aptitude for developing a data services strategy. However, this approach to working with a limited group had some drawbacks. In all instances, having a specialized group take on this task caused some tension with members outside the group as new workflows were established. In one instance at site D there were some indications that specialized data services were limited to individuals who had been hand-picked to introduce and develop the initial services, despite the desire of other librarians to provide similar services to their liaison charges:

So we are not part of the group . . . . She really heads up the group that manages library liaisons out into departments. We are thinking about collaborating together because we are providing different services and mindful that we are often working with some researchers in our community.  
(Librarian, University D)

### **Launching**

When faced with a new challenge, the human brain automatically applies strategies from past experience. This works well if the new challenge is similar to an old problem; when it is not similar, the solution from the past blocks new and improved ideas from emerging. When



implementing a transformational change it is necessary to have a clear break from the past and a solid plan for the future. “This requires the organized abandonment of things that have been shown to be unsuccessful, and the organized and continuous improvement of every product, service, and process within the enterprise” (Drucker, 2007, pp. 203-204).

According to Blanchard (2010), 29 percent of change initiatives are introduced without any formal launch or structure. The official beginning of a change effort helps people find new symbols with which to focus their thinking and create new meaning; transition rituals and opportunities to mourn the past and celebrate the future are important steps worth acknowledging. So too is being given the opportunity to understand why the need for change is important. Individuals must become emotionally connected to the new direction and must feel that they are part of something large, and important. All must work collectively towards the new direction or it will fail.

The leaders in the study were acutely aware of the importance of this phase of implementing change. Today, library resources are becoming easier to navigate and many tools are now available to assist library users to carry out research on their own. The role of the librarian as intermediary for information is less important than in the past (Hawkins, 2012). Each leader communicated to his or her followers that the skills they possess are still valuable; the skills just need to be applied to new situations and refined to work with new library users. Libraries and librarians will survive, but they will look very different in the future. As leaders they believed that this was the time to act, and that redesigning services to include data management was critical to the long-term success of the library and part of re-defining the future library.

## **Implement Changes**

Drucker (2007) noted, “The most effective way to manage change successfully is to create it” (p. 203). The leaders in the study, working with their supporters, communicated the need for change and translated that into an actionable plan for achieving the proposed future state. Library staff were well prepared to participate in the development and implementation of new programs and services.

The libraries studied started on a small scale by prototyping services. This was one way to get the change under way incrementally and to allow for flexibility in responding to changing conditions (Gilbert, n.d.). Library staff worked with a selected group of researchers who wanted to partner with the library to develop customized services. From there the staff built a more complete set of programs and services. This process allowed an opportunity to move more slowly and to document the deployment of new processes and technologies. This also helped to reinforce staff ownership of the change initiative.

## **Getting Results**

For leaders in the middle of a long-term change effort, getting results is essential. Leading a change effort without attention to performance is extremely risky due to the possibility of going in the wrong direction and never looking back to evaluate progress. Working with key team members, leaders in the study identified major milestones that could happen between six and eighteen months into the change. Getting these results helped ensure the overall change initiatives would continue. Companies that experience important short-term wins (within 14 to 26 months) after the change initiative begins are much more likely to complete the transformation (Kotter, 2005b).

To ensure success, the results must be both visible and unambiguous (Kotter, 1990), and related to the change effort. For example, the librarians at site C worked initially to help a selected number of researchers with their data needs (e.g., applying metadata, publishing past reports to the web, and developing custom portals for researchers to share data) and the librarians starting to have so much work that the library administrators recruited additional staff to help support the new programs and services. Once the librarians saw that the new services were needed, there was an increased sense of urgency and a surge of optimism encouraging those making the effort to change. Over time they gained an awareness of the potential for growth and for the ability to contribute in a meaningful way to the work of those in the research community. These short-term wins served to reward the change agents by providing positive feedback that boosted morale and motivation and also served the practical purpose of helping to fine tune the goals, objectives, and strategies and cement the change initiative (Kotter, 1996b). The need for results adds pressure to an organization in the midst of a transformation effort. However, the need to create results can actually increase the sense of urgency, and accomplishing these goals does much to cement the change initiative. A Focus Group Participant at site C spoke of the growth in demand and the effect that had on the library:

there is a slow build up where it was hard to have a success because we didn't have the services in place but we were risk taking and trying to get out there first to be leaders and so I think, in terms of being the leader, being the risk taker, I think as a reputation for ... [the university] as a whole, I think that's great.

## **Assessing Progress**

Transformational change takes time to implement and becomes apparent over time. One librarian (site B) commented, “Would we see a transformational change? The answer might be yes but we aren’t there yet. ... Or we are in the middle of it and we don’t know it.” This makes evaluating progress challenging. Having set goals and an implementation plan is helpful. The library administrators at the study sites addressed a series of critical issues to evaluate progress on implementation of the new vision for e-science services, such as the staff skills, accomplishment of work, and alignment of goals. These concerns get at the concrete aspects of implementation. But issues such as staff attitude, culture, and commitment are more difficult for any leader to evaluate.

## **Motivating and Inspiring**

Leaders energize people to overcome major obstacles when trying to bring about the desired vision (Kotter, 1990), and provide the tools needed to cope with the changing environment. This is done by satisfying basic human needs for achievement, belonging, recognition, self-esteem, a sense of control over one’s life, and living up to one’s ideals. Kotter (1990) suggest doing this by (1) communicating repeatedly the vision in a way that stresses the key values of the people being addressed; (2) involving those people in determining how to achieve that vision or some portion of it; (3) supporting their efforts with coaching, feedback, role modeling, and enthusiasm; and (4) publicly acknowledging and rewarding all their accomplishments. The leaders in the libraries studied made extra effort to communicate the need to embrace e-science, provided staff who were interested in the opportunity to experiment with services, and rewarded successes through recognition programs and increased responsibility.

## **Inspire and Energize**

Inspiring people over a longer period of time is difficult (Kotter, 1990). One strategy that all the leaders used was to send key library staff into the research community to spend time talking with and observing researchers to understand their workflow better and see where the library could offer support. They gathered stories and examples of what their local community needed and compared that with services offered at peer institutions. They shared their findings through informative presentations open to anyone on staff who was interested in learning more about data management and e-science.

## **Empower Subordinates**

According to Goldsmith (2010), it is not possible for a leader to empower someone to be accountable and make good decisions. “People have to empower themselves. ... [The leader’s] role is to encourage and support the decision-making environment and to give employees the tools and knowledge they need to make and act upon their own decisions” (para. 4). By doing this, leaders help employees to achieve an empowered state.

Building an empowering environment is in part contingent on the ability of a managerial leader to provide resources and support to those implementing the required changes, or in the case of the libraries studied, those developing the new programs and services. The managerial leaders created an environment in which they encouraged innovation and risk. The leaders also ensured that there were communication channels in place for the ongoing discussion of needs, opportunities, tasks, obstacles, projects, as well as what was and what was not working. In addition, each leader empowered those individuals who demonstrated the capacity to handle the responsibility, encouraging them to develop their skill set. The leaders gave people discretion

and autonomy over their tasks and resources and did not interfere with others' decisions and ideas unless it was absolutely necessary.

### **Maintaining**

Companies and organizations cannot thrive today without learning to adapt their attitudes and practices (Senge, 1999b). Organizations that establish change initiatives discover, after initial success, that even the most promising efforts to transform or revitalize organizations can fail to sustain themselves over time despite interest, resources, and results. That is because organizations have complex, well-developed immune systems, aimed at preserving the status quo (Senge, 1999b). Until new changes are rooted in social norms and shared values, they are subject to derision as soon as the pressure for change is removed (Kotter, 1995).

All of the leaders in the study addressed the issue of resistance by communicating frequently how the new approaches, behaviors, and attitudes were critical to the future of the library and the library profession. In addition, they took long-term administrative actions to ensure the success of the new e-science based programs by securing resources, such as additional staff, new spaces to work, and ongoing training opportunities.

### **Learning Organization**

The investigator observed the concept and principles of a learning organization as described by Senge (1990). A learning organization is one in which all systems, processes, and structures, at all levels (individual, group, department, and system-as-a-whole), constantly seek data on system performance and uses the data to make the organization more productive and creative. The organization seeks to position itself as best it can to ensure success in an uncertain future and in an uncertain environment (Corlett, n.d.). This type of organization is skilled at acquiring, transferring, and building knowledge that enables it continuously to experiment,

improve, and increase its capability. The learning organization is based on equality, open information, minimal hierarchy, and a shared culture that encourages adaptability and enables the organization to seize opportunities and handle crises. Leaders in a learning organization emphasize employee empowerment and encourage collaboration across departments and with other organizations. A key value is problem solving, in contrast to the traditional organization, which is designed for efficient performance (Daft & Lane, 2005). Senge (1990) argues that there are five core characteristics of a learning organization: (1) personal mastery, (2) mental models, (3) shared visions, (4) team learning, and (5) systems thinking (see Table 8.4 for the relationship among the characteristics). The principal element is systems thinking. Senge and his colleagues define a good systems thinker in an organizational setting as "someone who can see four levels operating simultaneously: events, patterns of behavior, systems, and mental models" (Roberts, Ross, Senge, Smith, & Kleiner, 1994, p. 97).

**Systems thinking.** Organizations, including libraries, are systems, bound by interrelated actions. Often major change in one area can affect another area, but the ramifications may not be evident until long after the change takes place. During times of profound change, since everyone is affected, it is difficult to see the whole pattern of change. Instead, individuals tend to focus on isolated parts of the system (those that have a direct impact on their assigned work), and speculate why some difficulties are never addressed. Systems thinking is a conceptual framework of knowledge and tools which helps to make the patterns of interaction clearer, and can assist organizations in seeing how to change these relationships effectively.

Table 8.4

*Characteristics of Learning Organization and Best Practices\**

<b>Characteristic</b>	<b>Definition</b>	<b>Associated Best Practices</b>	<b>Positive Byproducts</b>
Self-mastery	Ability to honestly and openly see reality as it exists; to clarify one's personal vision	<ol style="list-style-type: none"> <li>1. Positive reinforcement from role models/managers</li> <li>2. Sharing experiences</li> <li>3. More interaction time between supervisory levels</li> <li>4. Emphasis on feedback</li> <li>5. Work/life balance</li> </ol>	Greater commitment to the organization and work; less rationalization of negative events; ability to face limitations and areas for improvement; ability to deal with change
Mental models	Ability to compare reality or personal vision with perceptions; reconciling both into a coherent understanding	<ol style="list-style-type: none"> <li>1. Time for learning</li> <li>2. Reflective openness</li> <li>3. Habit of inquiry</li> <li>4. Forgiveness of oneself</li> <li>5. Flexibility/adaptability</li> </ol>	Less use of defensive routines in work; less reflexivity that leads to dysfunctional patterns of behavior; less avoidance of difficult situations
Shared vision	Ability of a group of individuals to hold a shared picture of a mutually desirable future	<ol style="list-style-type: none"> <li>1. Participative openness</li> <li>2. Trust</li> <li>3. Empathy towards others</li> <li>4. Habit of dissemination</li> <li>5. Emphasis on cooperation</li> <li>6. A common language</li> </ol>	Commitment over compliance, faster change, greater within group trust; less time spent on aligning interests; more effective communication flows
Team learning	Ability of group of individuals to suspend assumptions about each other and engage in dialog and discussion	<ol style="list-style-type: none"> <li>1. Participative openness</li> <li>2. Consensus building</li> <li>3. Top-down and bottom-up communication flows</li> <li>4. Support over blame</li> <li>5. Creative thinking</li> </ol>	Group self-awareness; heightened collective learning; learning up and down the hierarchy; greater cohesiveness; enhanced creativity



Table 8.4 (*continued*)

*Characteristics of Learning Organization and Best Practices\**

Characteristic	Definition	Associated Best Practices	Positive Byproducts
Systems thinking	Ability to see inter-relations rather than linear-cause effect; to think in context and appreciate the consequences of action on other parts of the system	<ol style="list-style-type: none"> <li>1. Practicing self-mastery</li> <li>2. Possessing consistent mental models</li> <li>3. Possessing a shared vision</li> <li>4. Emphasis on team learning</li> </ol>	Long-term improvement or change; decreased organizational conflict; continuous learning among group members; revolutionary over evolutionary change

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**Shared vision.** Within the libraries studied, managerial leaders who worked to bring about a transformational change also put into place the components of a learning organization. A central piece of the learning organization is the concept of shared vision — when everyone works together to create a vision, and then continues to work to incorporate that vision into each unit or part of the system. All members of the library understand and shape the vision. “The resulting vision is a creative synthesis (note, not convergence) of all that has emerged. ... Every member had heard his or her own aspirations reflected somewhere” (Roberts et al., 1994, p. 312). With a shared change vision in place it was easier for library staff to understand the need to incorporate e-science programs and services into the library’s offering and to bring commitment to the new direction the library was actively choosing.

**Self-mastery.** To develop and implement e-science services and programs required a personal commitment by library staff to learn new skills. In the learning organization this is known as personal mastery, the discipline of continually clarifying and deepening personal goals,

of focusing energy, developing patience, and of seeing reality objectively. There is an emphasis on results and on seeing the connectedness between individual learning and the commitment of both the individual and the library to bring about a new future. In each of the libraries interviewed, librarians commented on the need for self-study and consciously seeking out training opportunities to gain new skills and feel more competent when dealing with researchers. A Focus Group Participant at site B stated, “You learn from each new project you work on. Initially, that can be overwhelming but then you are like, I did it!”

**Team learning.** Much of the skill building was done as team learning, not to be confused with the concept of team building or functional teams<sup>8</sup> (Roberts et al., 1994). Team learning is described as people learning to think together, wherein thoughts, emotions, and resulting actions belong to all members together. The group then starts to work as a unit and the tedious process of planning and decision making becomes unnecessary (Roberts et al., 1994).

Team learning starts with dialogue, the capacity of members of a team to suspend assumptions and enter into a genuine state of thinking together (Senge, 1990). There are three key components of team learning: (1) teams must probe and explore complex issues, drawing on the talents, knowledge, and experiences of one another; (2) teams must work in concert, coordinating their efforts and communicating openly and closely; and (3) teams must interact with each other so that they can share what they learn.

At the sites studied several individuals were assigned to develop e-science programs and services. No one person could take on the responsibility alone due to the range of skills needed. In each of the sites a new department was formed and members worked together, learning from each other, to identify strategies, goals, and services. Throughout the process the information

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<sup>8</sup> A functional team is a unit of two or more people who interact and coordinate their work to accomplish a shared goal or purpose; the team is a group of people, but they are not equal (Daft & Lane, 2005).

gleaned during the learning process was filtered back to library leaders to help inform future directions.

**Mental models.** The extent to which individuals can participate in team learning and the other elements of the learning organization depends on the mental models from which they operate. Mental models are powerful thoughts and images that shape perceptions, and determine how individuals make sense of the world and shape how we act (Senge, 1992). They are embedded deeply in the mind and can be either simple or complex. Mental models explain how two people can see the exact same thing, yet describe it differently (Senge, 1990).

Vestal, Fralicx, and Spreier (1997) believe that, unless the culture of an organization is congruent with the new way of doing business, it will be difficult to obtain sustainable transformation. In the case of libraries that are actively moving away from a traditional past to define a new future, a change deeper than culture is necessary. Unless an organizational paradigm shift occurs the transformational change will not take hold. As discussed in Chapter 7, transformational change is defined as those periods in an organization's life cycle when there is a major shift in the overarching paradigm that guides the organization. Every change in the paradigm will necessitate changes in culture, mission and purpose, and processes (Levy & Merry, 1986).

### **Conclusion**

The ultimate goal of change management is to engage employees and encourage their adoption of a new way of thinking about and doing their jobs. Leading a transformation change is "an art that is pursued by highly effective leaders that want to continuously achieve extraordinary results for the organization they lead" (Ayars, 2009, p. 3). The library administrators in the case studies sought to implement transformational change. They did so by

taking the lead and establishing direction. They then ensured that staff had the necessary resources available to them and aligned everyone so all were working towards a new future for the library. There were clear goals, defined roles, and a conscious choice to make a change. In the libraries studied, administrators led people through the transformation process by involving them in planning and motivating them to work together to make the changes. In addition, they implemented a long-term maintenance program by fostering a culture that encouraged learning and team work.

The concluding chapter brings together the findings related to the research questions, as well as the additional conclusions that emerged in the various thematic chapters. The investigator draws conclusions about the cases overall, explores the implications of these conclusions for university libraries for the future, and suggests areas for further research.

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## **Chapter 9**

### **CONCLUSION**

Interest in providing programs and services related to e-science and data management is growing rapidly among university research libraries. This study documents how four libraries experienced comprehensive and radical changes in beliefs, values, attitudes, perceptions, and behaviors at the individual and group level in the process of initiating and engaging in e-science and data management programs and services. Throughout the transformation process a number of important themes emerged. These themes, reviewed in previous chapters, include the forces for change, the process of change, the types of change in terms of organizational structure and the roles of librarians, and the role of library administration in bringing about transformational change. This concluding chapter integrates these themes, focusing on the relevance and implications for those working in and leading university research libraries.

#### **Transformation in the Case Studies**

Libraries that defend the status quo and place their worth and value in past successes will soon find that they have lost their standing in the minds of many of those whom they purport to serve. R. Miller (2012) believes that the academic library will survive in some form as part of the university. Yet, he says “the real issue and challenge is to keep libraries relevant to the learning and research enterprise. The danger is that without major transformational change libraries will become less and less relevant” (p. 5). He argues that “change ... in academic libraries cannot continue to be incremental, but must be transformative” (p. 5). Incremental change, although easier to implement, will no longer sufficient to sustain libraries. While the literature about change in academic libraries often mentions the concept of transformational change (Association

of Research Libraries, 2010; Jaguszewski & Williams, 2013; Lowry, Adler, Hahn, & Stuart, 2009; R. Miller, 2012; Simmons-Welburn, Donovan, & Bender, 2008), relatively few scholars (Cuillier, 2012; Michalak, 2012) offer suggestions as to how to engage library staff and bring about transformational change. This study fills that void by using the framework of first- and second-order change established by Levy and Merry (1986) to document the processes of libraries that have gone through a transformational change.

First-order change occurs naturally as organizations grow and develop, and supports continuity and order; it is often consistent with current values and norms, is readily accepted, and can be incorporated into daily activities using people's existing knowledge and skills. Such change consists of minor improvements and adjustments in systems, processes, or structures, but it does not involve a fundamental change in strategy, core values, or identity (Levy & Merry, 1986). Second-order change (referred to henceforth as transformational change) involves not only developing the organization, but also transforming the core of the organization. It is "multidimensional, multi-level, qualitative, discontinuous, radical organizational change involving a paradigmatic shift" (Levy & Merry, 1986, p. 5). Second-order change challenges or conflicts with prevailing values and norms, and is a break from the previous way of thinking and doing.

The four cases in this dissertation demonstrate that a transformational change, as called for by the Association of Research Libraries (2010), Jaguszewski and Williams (2013), Lowry et al. (2009), R. Miller (2012), and Simmons-Welburn et al. (2008), occurred as a result of implementing e-science programs and services. In achieving this degree of change, the libraries studied underwent a number of common experiences which have been organized into the forces leading to transformation, the process of transformation, and the content of transformational

change. These experiences may provide insight for other university research libraries as to the range of issues they may encounter when engaging the research community and implementing e-science support and services.

### **Forces Leading to Transformation**

The first step in bringing about a transformational change is to respond to the forces for change that are emerging. Throughout this research, these forces are described in terms of enabling, permitting, pre-existing conditions, and triggering events (Lundberg, 1984). Enabling conditions are the external and environmental circumstances that influence research libraries, such as Web 2.0 technologies, reconceptualization of collections in all formats, and changes in undergraduate education to accommodate research-based curricula (Lowry et al., 2009). The enabling conditions described at the case sites focus on the amount of data being generated, the value placed on these data, the emphasis on collaboration within and without the institution, the formation of large international institutes, and in the effort to achieve institutional efficiencies, the provision of a comprehensive solution. The enabling conditions identified in the case studies are environmental factors that are affecting all research libraries. Kaufman (2012) sums up how these factors are associated with e-science and e-research: “growing demand for new services, such as those required by many research faculty who don’t know how to manage ... data ... compel academic librarians to look urgently both to other libraries and to other campus units for new ways in which to collaborate to deliver them” (p. 55). In the four case studies, university administrators looked to the library to play an important role and to contribute valuable experience, and the library administration, having helped to identify the problem, wanted to be part of the solution.

The university administrations' view that the library has an important role to play is fostered by the permitting conditions within the library, such as the willingness by library administration to get involved, transferable skills and expertise (e.g., cataloging, archives, and digital humanities), and pre-existing services (institutional repository services, liaison programs, special collections, and archives programs) on which to build. Other elements which are present in the libraries studied include a core group of interested staff, established partnerships with information services and the office of research, and stability in the library leadership team. These elements are the building blocks for going forward. Library administrators are willing to use permitting conditions to move beyond the parameters of earlier behaviors in order to pursue new services for aiding their institution, knowing that, if the libraries want to remain indispensable, they need to define and fulfill a new set of staff roles.

The libraries in the study turned these permitting conditions into actionable items because of pre-existing or precipitating conditions. According to Lundberg (1984), this includes the predisposition of an organization to grow and/or decline, to perform above or below expectations, to cope with the frustration experienced by organization members at the emergence of new unmet needs, to withstand external pressure from stakeholders who have a vested interest, and to meet a real or perceived crisis. The combination of past organizational experiences and the historical response to those experiences influence future changes. In the case study libraries, a number of past experiences were mentioned as foundational work applicable to taking a lead role in data management. One is a history of advocating for information policy and management, such as for copyright and open access. A second is having successfully responded to new initiatives in the past, such as developing historical collections and digitizing archival materials. Third, the librarians in the study believe that their strong history of teaching, demonstrating, and

incorporating new technologies into their own workflow and serving as a resource to others within the academic community was valuable experience on which to build. Finally, the strong desire and willingness to collaborate made the library an ideal partner. Library administrators also knew that if the library did not proactively seek to be involved in data management, it would be left out; they believed that the strong service focus of the library and its mission to support research were critical to the future success of the library in meeting the university's mission. Those library administrators advocated for library involvement through participating on university committees and meeting with university administrators, and worked collaboratively to solve the pressing issues related to data management.

One of two major triggering events consistently mentioned that propelled the libraries participating in the study into action was federal funder requirements for data management plans. This first occurred when the National Institutes of Health (NIH) created a policy for data sharing (National Institute of Health, 2003), which states NIH's position that "all data should be considered for data sharing" and "data should be made as widely and freely available as possible while safeguarding the privacy of participants, and protecting confidential and proprietary data" (National Institute of Health, 2003, Goals). At each of the study sites, library administrators and librarians took an active role in discussing the implications for their local research community.

It was in 2011, when the National Science Foundation (NSF) went a step further and mandated that researchers include a two-page data management plan as a supplementary document with any proposal for funding (National Science Foundation, n.d.), that libraries servicing research communities of all sizes started to take greater notice. However, the libraries in this study were ready to build on their previous experience with the NIH policy when approaching NSF researchers for the first time. As the librarians participating in the study talked

with members of the research community it became evident that the need for data services went beyond helping researchers write plans to meet NIH and NFS proposal requirements.

Researchers were beginning to ask for help organizing their data and requesting advice on long-term preservation.

The librarians in the study viewed funder data management requirements as an excellent opportunity to engage the research community. The NIH Public Access Policy and the NFS data management plan requirement helped establish that alerting researchers and keeping campus administrators well-informed about trends in data management were roles for librarians. As meeting the federal mandates becomes part of the researcher's workflow, so too does the demand for data-specific reference and instruction services beyond the focus of data plans. These include such activities as data citation, data preservation, and the computation of alternative metrics that take data production and reuse into account.

The second triggering event which each of the study sites mentioned occurred when a researcher in the university received a large data-intensive research grant. This was the catalyst for the university to start thinking more seriously about data management issues at the macro level. In one instance the researcher incorporated the library into the project at the planning and writing phases (library at site D). Being included at the planning phase offers the greatest flexibility and is the most cost effective, as the data management plan can be set ahead of time and data can be managed as they are created throughout the project. At sites A and C, researchers asked the library to lend assistance in managing data at some point after the projects began, especially towards the end of research, when publications and continued research funding place high pressure on a researcher's time.

In the case of library at site B, the library started getting involved in data management when a member of a research team, having just completed a project, determined that there would be value in preserving the data for the long term and approached the library for assistance. “At that moment in the research cycle, the cost of implementing late data management and sharing measures can be prohibitively high. Implementing data management measures during the planning and development stages of research will avoid later panic and frustration” (Van den Eynden, Corti, Woollard, Bishop, & Horton, 2009, p. 6). Although getting involved at the completion of a research project is not the most ideal situation, the library at site B, wanting to get more involved in data management, took on the project at its own expense. According to J. Wilson et al. (2010), good data management requires the input of the data creators, as they are usually the only ones in a position to document their methods and outputs accurately.

### **Process of Transformation**

Once the directors of the case study libraries decided to take an active role, the second step in bringing about a transformational change was to conceive an implementation plan to transition librarians into the new roles of data management consultant, embedded librarian, or informationist.<sup>1</sup> This required the library to dismantle processes and emotionally let go of old ways of operating while the staff deal with the changes and embrace the new culture. This transitional phase was project focused and was supported effectively with traditional change management tools (Anderson & Anderson, n.d.). Examples from the case studies include

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<sup>1</sup> An informationist (or information specialist in context) provides research and knowledge management services in the context of clinical care or biomedical research. The term was first coined by Davidoff and Florance (2000) and has been gaining momentum since 2010 when the National Library of Medicine (NLM) launched a support program at the National Institutes of Health: NLM Administrative Supplements for Informationist Services in NIH-funded Research Projects. Rather than offering support to an individual for coursework, an immersion experience and research project, this program seeks applications from NIH-funded extramural scientists who wished to add an informationist to their research teams. The launch of this grant supplement program was made possible with participation of various organizations; seven of the 23 Institutes and Centers at the National Institute of Health that fund extramural research participated, including NLM. Eight awards were made, bringing 15 librarians at six different universities into existing research teams at their organizations (Florance, 2013).

reorganizations, creation of new products or services that replace programs in lower demand, and the implementation of new technologies that did not radically impact people's work (e.g., an institutional repository) or require a significant shift in culture or behavior to be effective.

According to Anderson and Anderson (n.d.), there are two indicators that define this transitional period, and both are applicable to the case studies. The first indicator is linked to managing change. While in the transitional phase, library administrators determine the goals of the change initiative before it begins, and can, therefore, manage the process. In the case studies, library administration closely monitored the process of change and provided support and guidance throughout. The second indicator identified by (Anderson & Anderson, n.d.) focuses on what is happening to employees during the transition. The librarians in the case studies were asked to do many things throughout the transition, such as seek new relationships in the research community and partner on research grants, but primarily in preparation for their new role they were asked to learn new skills and take on new duties related to data management.

This dissertation research outlines a common process<sup>2</sup> used by the libraries participating in the study and compares that process with other change models. This common process may be of some use to other libraries. The fact that a common process could be identified indicates that there are identifiable specific issues that libraries must address, or at a minimum acknowledge. Yet, one problem with proposing a change process to engage in e-science is that one can misinterpret the process as being the only way to bring about such a change successfully. Librarians and library administrators contemplating participating in e-science activities as a result of external pressures need to be aware of the local environment and any unique needs and policies that could affect how such a change is implemented and received within the community

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<sup>2</sup> Common steps used by the study sites are: (1) identify the need, (2) decision to act, (3) resources assigned, (4) partnerships formed, (5) paradigm shift, (6) demand increases, and (7) institutionalization of the changes.



the library serves. Additionally, implementing change in a set or planned approach is based on the assumptions that organizations (e.g., libraries) operate under constant conditions, and that they can move in a pre-planned manner from one stable state to another. Several authors (Burnes, 1996, 2009; D. Wilson, 2000) writing in the corporate world suggest that the current fast-changing environment increasingly weakens the likelihood of success if flexibility is not incorporated into the change process.

### **Content of Transformational Change**

The third and final step to bringing about a transformational change, and also the most difficult, involves changing organizational culture and individuals' views of what it means to be part of a library. Using the theory outlined by Levy and Merry (1986) that transformational change deals with radical, fundamental, and total change in which an inner shift in people's values, aspirations, and behaviors combines with outer shifts in processes, strategies, practices, and systems, this study suggests that a transformational change occurred in the four libraries that participated in the study. The context in which this change transpires is providing e-science programs and services; "While libraries may have little immediate engagement in these processes, clearly e-science has the potential to be transformational within research libraries by impacting their operations, functions, and possibly even mission" (Joint Task Force on Library Support for E-Science, 2007, p. 13). Levy and Merry (1986) maintain that the content of transformational change occurs in four dimensions: functional processes, mission and purpose, culture, and finally the organization's world view or paradigm.

**Functional Processes.** There were common changes in process across the four case studies, such as forming new departments, creating new positions, offering new services, reaching new groups, and staff assuming new responsibilities. These types of changes, referred

to as functional or first-order changes, are general enough that they can apply to many initiatives in university research libraries. For example, shifting from a print-based journal collection to an electronic collection results in creating new positions and reorganization of technical services staff, but does not require a change in culture or organizational paradigm. The Association of Research Libraries (2010) calls for more than first-order change when addressing issues related to data management, making it clear that the mandate for transformation is both broad and deep.

**Mission and Purpose.** The directors participating in the study do not see e-science programs and services as changing the mission of the library; in fact, all of them said that supporting e-science is part of their existing mission. What does change, or a better word may be expand, are the roles the library staff are willing to assume to fulfill the mission. For libraries debating whether or not to start offering e-science services such as data management, and others who are already involved and considering expanding services, it is important to address the question of mission alignment; straying from the core mission may cause problems. Some issues that may cause libraries to stray from their core mission include data storage, data mining, and supporting the technical infrastructure to facilitate data exchange. Only individual librarians and their directors can determine whether the library has a role in such services and if there is a local need that is not being fulfilled elsewhere in the university. Halbert (2013) confirms the need for communication across the institution to identify roles in this area: “effective research data management practices will require close working relationships between divisions of the university, sometimes to the point of blurring boundaries in uncomfortable ways” (p. 5).

Despite the environmental differences present in each of the libraries, the directors set a common goal to make a change to the underlying metarules, that is to say the underlying assumptions, world view, or what is defined by Levy and Merry (1986) as a paradigm. Second,

they all ultimately sought to create visions, choices, ideas, and directions that went beyond the confines of the current paradigm. Third, they all focused on the organization's members' perception of reality, considered what shaped this perception, and finally challenged this perception with something new. In the end, the library recast its role in the university in relation to the changing needs of the academic community it serves.

**Changing Organizational Culture.** Organizational culture consists of group norms of behavior and the underlying shared values that help keep those norms in place; it characterizes the way people work together. It also includes symbolic actions and components such as myths, rituals, ceremonies, the layout of the physical setting, and the style of management and relationships. In order for transformative change to be implemented successfully, the organization's culture needs to be aligned with the proposed change. This involves evaluating how the existing organization's culture might positively or negatively influence the change that needs to take place and then working to adjust the culture, as needed, so that it supports the change.

Discovering a way to confront the old culture in order to align it with rapidly occurring change requires a deep understanding of the historical context in which the library operates in the local environment. Varner (1996) noted:

[When] the change in academic libraries entails more than the addition of new technologies [a first-order change] – it encompasses a transformation of organizational culture. A culture founded on unquestioned assumptions about the nature of library work must give away to a culture whose members continually seek to disconfirm long-held assumptions and to change as needed. (p. 2)

The directors and associate directors at each of the study sites indicated that it took time and effort to align staff and for everyone to understand the importance of the changes and support them. The leaders believed that bringing about change was imperative to remaining effective, yet different subcultures within the library surfaced and were not sure how offering e-science programs and services and taking a lead in data management related to them. R. Miller (2012) describes this situation:

Others have avoided new digital initiatives to concentrate on traditional core activities such as reference or bibliographic instruction or preservation or ... binding. In other words, they are retrenching so that essentially they are maintaining their traditional mission and identity, instead of engaging in activities that might define a future different from the past. (p. 7)

It poses a challenge for both the administration and the staff to understand these subcultures and to help all staff members, even those that resist change, to pull together to create new organizational values that help the library operate in the new environment. R. Miller (2012) argues that library leaders cannot continue to keep all of the traditional assumptions of what a library is and continue to add new programs and services. He believes, “We must question old assumptions, even values-based ones that we have not questioned in the past, and push hard toward our vision of the future role and mission of the library” (R. Miller, 2012, p. 7).

Library administrators in the study are among those committed to broadening the scope of library engagement and working closely with the research community. They sought participation and collaboration as they worked to change the underlying culture, knowing the new actions will be successful when staff acknowledge the need for change and feel that they have a role in shaping the new culture rather than simply having a cultural change imposed on

them. Librarians at site C commented that the director promotes the library's data management services across campus. The director modeled the behavior expected from his librarians; "Most people won't change their behaviors until they observe the role models in their organization acting differently and when they see this new behavior positively recognized and rewarded" (Bridgespan Group, 2011, p. 1). In addition, each of the library administrators sought participation from key library personnel to help define the scope of the new services. By letting librarians participate in formulating the implementation of new services, they were providing an opportunity not only for librarians to be a part of the change, but to also redefine their personal role in the library and see how they contribute to bringing about a new culture. One important aspect of this change is the way in which the employees are willing to embrace risk, flexibility, and adaptability. As these new actions produced results, the outcomes were communicated and celebrated, new norms were formed and new shared values began to take hold.

**Changing the Organizational Paradigm.** An organizational paradigm is defined as a world view, a frame of reference, or a set of assumptions, usually implicit, about what sorts of things make up the world, how they act, how they fit together, and how they are interpreted (Levy & Merry, 1986). Armenakis and Harris (2002) indicate that presenting a new paradigm is only possible after those effected are aware of the transformation process that is taking place within the organization and after they have accepted the need for a major change. This was the case within the libraries in the study. Comments such as "rapid little steps," "everything is processed," and "hurry up and wait" are indicators that the paradigm shift came in stages, beginning with incorporating functional changes that did not challenge the original paradigm. Some examples of functional changes that are represented in the case studies include purchasing datasets for users and storing small datasets in the local institutional repository.

At the study sites, over time, as the amount of data being generated across the institution multiplies and funders start implementing data management and sharing requirements, the simple requests to store small datasets turn into substantial requests to develop data management plans and manage large amounts of data. This is referred to, throughout the present research, as the tipping point and brings the issue of data management into the forefront of library administrators, who view this as a critical point, or the proverbial fork in the road, in which a new state of being could emerge if managed properly. Levy and Merry (1986) describe this as the “letting go” and “holding on” process (p. 294) and involves formalizing the new paradigm within the library and within the larger context of the organization.

As the paradigm began to change at the study sites, librarians experienced a shift in the way they conceptualized the library and viewed its purpose in the institution. By engaging with the research community and taking an active role in research data management, the librarians were reshaping themselves into research partners with skills that are valued throughout the entire research process.

The call for a paradigm change is designed to bring the university and the external environment into the library’s planning and program development, creating an opportunity to change the thinking of what it means to be a university research library. This is done by inviting provocative thinkers to engage and discuss on issues relevant to e-science and data management. With the open exchange of opinions, librarians, staff, and leaders alike are able to speak up, ask questions, and contribute to the new view. As well, library staff are engaged and take part in a purposeful dialogue which allows new ideas about the role of the library to take firm root in the organizational culture.

A change in a paradigm does not occur rapidly and may incorporate elements of the old paradigm (while redefining its meaning) rather than fully rejecting it. In the case of the libraries participating in the study, there was a sense of growth and forward movement, as if engaging in e-science programs and services was the next major step forward, and that it incorporated existing skills and provided opportunities for new development. The beginning and end of a paradigm shift are hard to identify. It may be, as suggested by a librarian at site B, that the full extent of the change in world view can only be understood after it has been in place and is functioning as the new norm.

### **Leading Transformational Change**

This research refers to library administrators as managerial leaders, because as leaders they influence others, create a vision for constructive change, and develop mutual purposes, while at the same time serving as managers involved in the effective planning, organizing, staffing, and controlling the organizations (Lim, 2012). As directors and associate directors, these managerial leaders lead a major change initiative and guide the library staff through a process of reinvention and rejuvenation.

It is important to note that not all changes represent the same order of change for each individual or stakeholder group. Change that some experience as first-order change may be transformational change for others. Using practices that might be appropriate for first-order change when transformational change is actually desired will likely result in a negative impact. Thus, it is important that managerial leaders be aware of how staff are reacting to change and tailor their own leadership practices based on the order of change they are leading and where they are, and the staff are, in that process.

## **Role of Library Administration**

For managerial leaders, the role of director and associate director in the libraries studied involves many aspects, such as providing direction, formulating strategy, helping others grow, eliminating obstacles, inspiring and motivating, acting as a coach and mentor, and listening to constituents. Some of the roles they mentioned can be grouped based on the direction or focus of their efforts, that is, whether they are internal or external to the library. One external role in which directors and associate directors participated was influencing dialog at the university level on data policies and procedures and making recommendations for long-term preservation of data. Further, as managerial leaders, the directors represented the library at the university level and promoted the librarians as research partners. Finally, managerial leaders secured funding from the university administration to support the library as it transitions into a role in which the work and support that the library offers to the researchers can be funded by grants.

These roles were not new to the directors and associate directors, but were a critical part of the library's continued involvement in e-science, and specifically data management. By participating in the dialogue at the university level, they continually advocated for the library's involvement and offered the skills and expertise of the library staff to assist in developing lasting solutions. This visibility also served as a forum in which to develop and solidify the working partnerships among the library, the office of research, and information technology services. Each of the participants at the four study sites commented on the need to have these three organizations working together in order to provide comprehensive solutions to the issues associated with data management.

Internally, the director and associate director assumed roles such as providing the framework for the development of the new e-science based programs and services and



highlighting the importance of forming partnerships within the research community. They had the responsibility for communicating how e-science is an important component of the library mission. In addition, they showed librarians and other staff members how they fit into the change process, and they ensured that everyone shares a common focus by creating buy-in and communicating the importance of transitioning into new roles. They also ensured that the librarians were equipped to do the new work.

### **Role of Vision**

To determine strategic direction for the future, managerial leaders look inward, outward, and forward. They scan both the internal and external environment to identify trends, threats, and opportunities. The result should be both a broad and inspiring vision and an underlying plan for how to achieve it. The managerial leaders in the case studies used a change vision, a picture of what the organization will look like after significant changes are achieved. In communicating the change vision, managerial leaders outlined the opportunities that would be available to the organization once change was fully realized.

The change vision which each of the library administrators put forward served as the inspiration and motivation for the transformational change. It provided focus and encouraged workers to take risks and find new uses for existing skills. Most importantly, the change vision was able to link the present to the future. The directors in the study communicated a sense of urgency and the danger of being left behind if the library, as an organization, did not rethink its role in the university. The change vision challenged the library staff to expand their thinking on how the library operated in the university environment and how their individual roles would change. At each of the sites, the director was able to identify a core group of librarians that were ready to take up the challenge.

## **Team Leadership**

Library administrators at all four sites participating in the study formed a new department or team to implement the change initiative. A team is a specific group composed of members who are interdependent yet share common goals; the members must coordinate their activities to accomplish these goals. In the libraries participating in the study, teams included members with a variety of skills, experiences, and authority, and were led by either the director or associate director. This composition of members had sufficient authority to eliminate barriers. The teams were given access to resources such as training, financial resources, and the freedom to take risks. The teams were empowered with decision-making authority, which gave them the autonomy to solve problems and make critical choices about the future of the team.

Team leadership is “individuals’ purposeful efforts to influence their team and its members toward the achievement of objectives and goals” (Ziegert, 2005, p. 4). In the teams formed in the case study libraries, the director or associate director provided the leadership and kept the teams moving in the desired direction, yet within the teams, leadership was shared. Shared team leadership exists when multiple team members exert downward, upward, and lateral influence on their fellow teammates in an effort to realize team goals (Ziegert, 2005). In shared team leadership, the formal leader can still perform leadership behaviors; however, this individual is just one of the many potential team members leading the team. Leadership is not confined to director and/or associate director; others may serve as leaders when appropriate and then revert to being team members or followers. For example, in the library at site C there were times when the individual with the most technical experience led the effort for a period of time when issues of infrastructure and technology were most pressing, and at the library at site B the librarian who best understood the NSF data management plan requirements would take the lead.

Even if the managerial leader was sharing leadership responsibilities, the library administrators communicated to the teams they formed an important underlying assumption, that the members were willing to accept the world view (organizational paradigm). All members, leaders included, had to be willing to change themselves first. They were asked to let go of many of the assumptions that guided their behavior in the past. One example of an assumption that needed to change was expressed by a member of the library at site C: “librarians only support research; they don’t conduct research.”

### **The Library as a Learning Organization**

A learning organization facilitates the learning of its members and transforms itself in order to meet its strategic goals (Haley, 2010). Employees, teams, and leaders continually adapt in response to ongoing changes as they occur. Employees should not be passive recipients of knowledge and skills perceived by others to be necessary; they identify what they already know and how that knowledge can serve as a platform or structure for further learning and development (Haley, 2010). Thus, learning organizations learn and adapt continually in order to survive and grow.

In the libraries participating in the study, the investigator observed a cycle of action, feedback, and synthesis. As librarians interacted with the research community and formed partnerships, they gathered feedback on those experiences from everyone who was involved, reported back, and worked with library administrators to discuss the process. All of this information was considered and adjustments were made going forward, so that the next time librarians had an opportunity to forge new relationships or assume embedded roles; they were better prepared.

The investigator also observed that during the time of transition, library administrators made themselves available. Strict hierarchical structures were set aside. Rather, structure was based on workflows and processes; the goal was to create mechanisms that allowed for easy communication, coordination of efforts, and sharing of knowledge. At site A, the library director commented on how the flat organizational structure facilitates her involvement and keeps her close to the day-to-day operations of the e-science and data management initiatives. The library director at site D told how each year he forms a new management team, not based on position but rather on skills that are relevant to the annual goals and objectives.

In this way the librarians were shifting from task-based<sup>3</sup> assignments to assuming open roles in the newly defined paradigm of the library. When a librarian assumed a role, there was discretion and freedom to make decisions and react quickly to changes. Throughout this process, librarians were constantly learning. Within the learning organization, new skills are acquired, transferred, and shared as new knowledge enables the library to experiment, improve, and increase its capabilities.

### **Staffing and Skills**

The Institute of Museum and Library Services has supported a number of initiatives to develop the skills and tools used in data management. These include the Information: Curate, Archive, Manage, Preserve (iCAMP)<sup>4</sup> project at the University of Northern Texas and the New England Collaborative Data Management Curriculum (NECDMC)<sup>5</sup> led by the Lamar Soutter Library at the University of Massachusetts Medical School. Even so, one common statement

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<sup>3</sup> A task is a narrowly defined piece of assigned work (Daft & Lane, 2005).

<sup>4</sup> The iCAMP Project is a three-year effort (2011-2014) to build capacity for educating librarians and researchers for digital curation and data management. This end result will be a set of graduate level courses offered at the University of North Texas.

<sup>5</sup> The NECDMC project is an instructional tool for librarians to assist in teaching data management best practices to undergraduates, graduate students, and researchers in the health sciences, sciences, and engineering disciplines.

made by those library directors at the study sites when they considered getting involved in e-science and data management is that they did not have staff with the appropriate skills; “Currently librarians lack the technical skills needed to manage and curate terabytes of digital data” (Creamer et al., 2012, p. 22). The same can be said for others in the academic community; “almost no one within the academic community receives systematic professional training and certification in the management of research data ... librarians may be the closest to understanding their role” (Halbert, 2013, p. 6) .

The library administrators and librarians in the libraries studied made similar comments, but they did not let the apparent lack of skills stop them from moving forward. Specifically, the directors said they needed staff who had technical expertise and project management skills, understood the research process, and had some domain knowledge. All of the skills related to e-science, they suggested, could be learned. “Most stakeholders (including libraries) also acknowledge that libraries cannot manage research data alone” (Halbert, 2013, p. 6). It will require cross-campus collaboration with researchers, information technology, and offices of research. The directors in the study identified the need for librarians to possess excellent interpersonal communication, self-confidence, and willingness to approach new people in order to be effective team members. They sought people who possess initiative and the ability to advocate for the library and themselves. If these skills were not present among the current library staff, they sought to hire a new librarian to help with the change initiative.

### **Barriers to Implementing Transformational Change**

Even well-conceived and well-supported change efforts, like those of the libraries participating in the study, run into problems and impediments, particularly when there is no prevailing model among their peer libraries to offer guidance as they undergo their

groundbreaking efforts. The contributors to the study have been forthcoming about the barriers to getting started.

Many of the barriers identified in this study relate to the time it takes to implement a transformational change. The library administrators and librarians in the study knew it would take a while to implement e-science based programs and services and to incorporate these services into the larger workings of the library. One reason is the effort it takes to develop and communicate the need for change. Within the small groups of people assigned to work on e-science initiatives, there was a common desire to move forward and develop services. Yet, it was also important to ensure that the personnel outside of the planning groups in all of the libraries understood and bought into the significance of how this new role moved the traditional academic library into a new direction with regard to services and programs.

It also takes time to develop an implementation plan for change. Setting up new departments, shifting personnel, writing new job descriptions, and hiring additional staff require organization and working with within the university structure. The library director at site D specifically commented on the difficulty of working with the Human Resources department to explain the changes in job description, qualifications, and appropriate salary ranges.

Awareness of the need to obtain new skills, not to mention translating the new knowledge, skills and abilities into practice, is also a slow process; “Training is a starting point ... there has to be follow-through, reflection, feedback, and practice over a long period of time for real change to take root” (Diaz & Phipps, 1998, p. 410). Although the library administrators in the case study libraries had been thinking and planning for e-science for more than 10 years they indicated that, as members of ARL, they continue to be actively involved in the programs

and training sessions being offered by ARL, such as the E-Science Institute.<sup>6</sup> Organized activities like the E-Science Institute help librarians to learn from one another and build peer networks. These types of opportunities also serve as an outlet for ideas to be exchanged and best practices to be shared.

Two additional issues related to time are the process of building lasting working relationships with the research community, and funding cycles. An important milestone for the librarians in the study was partnering with a researcher on a data-intensive project from start to finish. Forming a working relationship in which the librarian is welcomed into a research team as a full partner requires a combination of the technical and non-technical skills previously mentioned, and a number of other factors which also need to align. Some of the most critical points are:

- the time period of the grant;
- how well the librarian fits with the research team;
- the availability of a mentor for the librarian;
- the proposed role of the librarian; and
- the availability of funding to pay for the librarian.

Addressing these issues requires a strong working relationship between the researcher and librarian.

Organizational change is more of an open-ended and continuous process than a set of pre-determined separate and self-contained actions (Burnes, 1996, 2009). Attempts to dictate

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<sup>6</sup> The E-Science Institute is designed to help research libraries develop a strategic agenda for supporting research in the sciences. Its scope is not limited to the types of scientific research requiring very large scale computing (i.e., computational science or high performance computing) but includes all aspects and types of computer supported research including data production and curation, social interaction (e.g., virtual research environments), online publishing and scholarly communication, and the use of physical space for computer-based group activities (Association of Research Libraries, 2011).

timetables, objectives, and methods in advance, results in the process of change becoming dependent on administration, moving away from engaging other stakeholders in the process, and failing to take into account the fast pace of change (D. Wilson, 2000).

### **Recommendations for Future Research**

E-science and its effect on libraries are in the beginning stages of development, study, and research. This research represents the start of an exploration of the changes occurring in university research libraries and the leadership issues associated with those changes. A number of elements are worthy of particular attention, and some of these are explored below.

#### **Evolving Role of the Library and the Librarian**

This study identifies numerous library staff roles related to data management education, information policy, research, and service offering. Additional studies that examine roles beyond these categories would benefit the library community as librarians look to expand the programs and services currently offered. Similarly, studies that focus on outcomes and the impact of library involvement in e-science and data management projects will contribute useful information to those libraries debating whether or not to get involved.

This study confirms that librarians working in the area of e-science need both technical and non-technical competencies (as suggested by Creamer et al. (2012)). An analysis of how librarians are acquiring these skills (e.g., continuing education in library and information science master's programs or offerings of professional associations, or on the job training), and whether the educational goals match what is needed in practice will help those who are considering seeking additional education, as well as those who are designing and offering educational and training programs.



It is worthwhile to learn more about librarians who assume roles as embedded librarians or informationists. A better understanding of their experiences, how their role has evolved over time, and the hurdles they faced will benefit managers and leaders who are encouraging librarians to move in this direction. As these librarians move out of the physical library building and partner with researchers, it is useful to explore how they maintain professional identity and whether they start to identify more with the research team and less with the library (as indicated, for example, by professional memberships and affiliations).

As librarian roles evolve and the culture of the library embraces change as a normal state, the ramifications for librarians and library staff working in unionized environments needs to be examined. A study that investigated the process and issues associated with bringing about transformational change in unionized library environments will be of value to workers and leaders in such settings. This would build on the research by Lim (2012).

### **Concepts of e-Research/e-Scholarship**

This study, focused on four libraries that are members of ARL, approaches e-science as a subset of e-research; e-humanities and e-social sciences make up the balance of e-research. As research continues to grow and become more multi-disciplinary and interprofessional education<sup>7</sup> becomes more popular, the distinctions among humanities, social sciences, and the sciences blur. One effect on university research libraries is the closing of departmental libraries. How well these libraries are incorporated back into the main library is not known, especially if one of the libraries is moving away from traditional library services and embracing transformational change. Scenarios that look beyond libraries that are members of ARL and extend library e-

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<sup>7</sup> “Interprofessional education involves educators and learners from 2 or more health professions and their foundational disciplines who jointly create and foster a collaborative learning environment. The goal of these efforts is to develop knowledge, skills and attitudes that result in interprofessional team behaviors and competence. Ideally, interprofessional education is incorporated throughout the entire curriculum in a vertically and horizontally integrated fashion” (Buring et al., 2009, p. 1).

science and e-research services into the future could help libraries facing the challenge of merging services.

### **International Comparisons**

Although data curation and management are principal components of e-science support and services in U.S. university research libraries, in the United Kingdom, national data centers are more active in developing these services (L. Molloy, 2013). Comparative studies involving the United States, United Kingdom, and other countries such as Australia, Germany, and Canada, would be useful. These countries have promoted the use of national data centers as part of national information policy. Studies that seek to understand the advantages and disadvantages of this type of approach, implementation issues, and final outcomes will be useful for all involved in implementing data management and curation programs, especially those who are overseeing implementation in the United States.

One characteristic of e-science is its collaborative approach to data collection, especially in trying to answer global questions such as those posed in meteorology, astronomy, and human genomics. As researchers form national and international partnerships questions arise as to how libraries support such research teams, and about how librarians collaborate and work together to meet researcher needs.

### **Strategic Partner and Institutional Perspective**

Cooperation and collaboration are not new concepts in academic librarianship (Kaufman, 2012). A closer examination of the working relationships among the library, university administration, and strategic partners on campus in regard to data management and e-science will inform planning efforts involving collaboration. Answering questions about how collaborators

are identified and what each partner brings to the relationship could provide meaningful data and useful information for libraries that want to form new partnerships across the university campus.

### **Transformational Change in Systems verses Subsystems**

One of the main questions about transformational change is the relationship between a transformational change in a system and a change in one of its subsystems. This study asks if a transformational change has occurred, but a closer examination as to whether the transformational change occurred at the systems level or within a subsystem could be helpful. Does a transformational change in a subsystem necessarily lead to a first-order change in the system? The effect of change in the subsystem on the entire system probably depends on the centrality of the subsystem and how closely it is tied with other parts of the system. It is possible that in organizations, a transformational change cannot come about through transformational change in a subsystem. Perhaps transformational change can occur only by a change in dimensions (core processes, mission, culture, or paradigm) that affects all subsystems. This concept deserves further study.

### **Transformational Change and Environmental Support**

Another area for further study is the degree of dependence of a transformational change on the support of the university environment; transformational change is difficult if there is strong resistance from within that community. Holloway (2004) observes that “implementing a new structural organization within a university is not for the faint-hearted. It takes courage of conviction as well as support from university administrators” (p. 8). In this instance, if the university is against the library assuming a role in e-science, is it still possible for the library to experience a transformation? What factors affect this? These questions need further research.

## **Sustainability of Transformational Change**

Kotter (2013) wrote that 70 percent of change efforts fail and only 5 percent of change efforts achieve all of their stated objectives. But what happens to an organization that is able to achieve a transformational change? Is it sustainable? Senge (1999a) states:

This failure to sustain significant change recurs again and again despite substantial resources committed to the change effort (many are bankrolled by top management), talented and committed people "driving the change", and high stakes. In fact, executives feeling an urgent need for change are right; companies that fail to sustain significant change end up facing crises. By then, their options are greatly reduced, and even after heroic efforts they often decline. (p. 6)

A follow-up study that examines long-term stability of transformational change in academic libraries will benefit the library profession as a whole, since library managerial leaders address issues of change and how to sustain change for the long-term on a daily basis regardless of the context and type of library. How do libraries that are successful in implementing a transformational change continue to move forward, so that transformational change is a continuous process and is embedded into the library culture?

It will also be of value to examine the role of teams in bringing about and sustaining transformational change. Martin (2004) was the first to examine the role of teams in academic libraries using Hackman's (2002) criteria for team effectiveness. The libraries in the four case studies formed working teams to initiate and implement their desired changes. How do the outcomes of these teams measure against Hackman's (2002) and Martin's (2004) application of those criteria in libraries?

## Conclusion

The massive amounts of data being generated as a result of computationally-intensive research and funders' requirements to preserve and share data have propelled research universities and their libraries to become engaged in e-science. Librarians have transferable skills and experiences which allow them to assume critical roles in e-science initiatives at department and institutional levels. The functions these skills support include data management education, information policy, research, and service development; all are applicable to data management. A number of structural and programmatic changes are occurring in libraries to provide e-science services and programs; these include re-defining the role of the librarian and the transformation of the library into a learning organization. These changes are more than incremental or functional; they involve culture, organization paradigm, and vision. Embedding librarians throughout the entire research process challenges the traditional view and purpose of the library, redefining the role of librarians. The result is a transformational change.

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## Appendix A

### E-Mail Message to library directors from dissertation committee chair

Dear \_\_\_\_\_,

I am writing on behalf of Mary Piorun, who is one of the students in the PhD program in Managerial Leadership in the Information Professions. She is seeking a greater understanding of why libraries are getting involved in e-science, the role they are assuming in this area, how libraries are partnering with other campus organizations, and the effect on the library.

We would like to request your participation in the study. This involves Mary visiting your campus for approximately two days at a time that is most convenient for you in order to conduct interviews and review any relevant documents that you are able to supply. The interviews would be both internal and external to the library. Internally, she would conduct a personal interview with you, the associate university librarian responsible for overseeing e-science programming and services, and a librarian who is providing the services. Externally, we request your assistance in arranging personal interviews with those you consider relevant. They might include the Vice Provost for Research or a designee, and one to three personal interviews, as you think appropriate, with those departments or organizations on campus with which the library is partnering. Mary would also like to obtain any documents that you can share related to implementing e-science programs and services at your library and at the institution. These documents can be anything related to strategic planning, setting priorities, progress reports, and visioning exercises, as well as any memos and meeting minutes that detail your work in e-science.

A separate invitation to participate in this study will be sent via the US Postal Service. I sincerely hope that you will be able to take part in this study. I am happy to address any questions you may have about participating in this study, and would like to thank you on behalf of the program for considering to be part of this research project.

Sincerely,

Peter Hernon, Professor & PhD  
Graduate School of Library and Information Science  
Simmons College  
300 The Fenway  
Boston, MA 02115

(P) 617-521-2794  
(E) peter.hernon@simmons.edu

## **Appendix B**

### **Invitation to participate**

Dear \_\_\_\_,

In today's highly collaborative, data-driven research environment, a number of libraries serving research universities with membership in the Association of Research Libraries (ARL) have moved beyond the traditional roles of providing access, organizing, and ensuring preservation of information. They have been showcasing their value and relevance by identifying new roles and seizing opportunities to partner with researchers as they become more involved in e-science. This study is investigating why research institutions and libraries became engaged in e-science, their future directions, and which strategic partners are critical for success. The study is also exploring the changes occurring in libraries in order to provide e-science services and programs and the role of leadership in bringing about those changes.

Will you participate in this study? If so, I would like to plan to visit your campus for approximately two days, at a time that is most convenient for you, hopefully this summer or early fall, in order to conduct interviews and review any relevant documents that you may be able to supply. Any data I gather will be kept in the strictest confidence and my dissertation will not allude to you personally in any way that an outsider could identify.

The interviews I am planning would be both internal and external to the library. Internally, I plan to conduct a personal interview with you, the associate university librarian responsible for overseeing e-science programming and services, and a librarian who is providing the services. External to the library, I would request your assistance in arranging a personal interview with the Vice Provost for Research or their designee, and one to three personal interviews with those departments or organizations on campus with which the library is partnering.

I would also like to obtain any documents that you can share related to implementing e-science programs and services at your library and at the institution. These documents can be anything related to strategic planning, setting priorities, progress reports, and visioning exercises, as well as any memos and meeting minutes that detail your work in e-science.

I would like to call you to share more information on my research study, provide you with specifics regarding the interviews, and answer any questions you may have for me. If you can suggest some times for a phone call in the next week or so, I would be happy to accommodate your schedule.

Thank you in advance for any assistance you can offer.

Mary Piorun  
PhD Candidate  
MLIP, Simmons GSLIS

## Appendix C

### Consent form

#### CONSENT TO PARTICIPATE IN RESEARCH

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The Library's Role in E-Science Programs  
in Research Universities

Mary Piorun: Library  
(E) mary.piorun@umassmed.edu

**Invitation to Take Part and Introduction:** Mary Piorun, a doctoral student at Simmons College in Boston, Massachusetts, is conducting a research study under the direction of Dr. Peter Hernon and her dissertation committee at Simmons College. The study will explore how and why research institutions and their libraries became engaged in e-science, how e-science is conceived and implemented, and also investigate the changes occurring in libraries in order to provide e-science services and programs and the role of leadership in bringing about those changes. You are invited to participate in an interview because you have been involved in e-science activities at your institution.

**Purpose of Research:** To explore how and why research institutions and their libraries became engaged in e-science, how e-science was conceived and implemented, and also to investigate the changes occurring in libraries in order to provide e-science services and programs, and the role of leadership in bringing about those changes.

**Your Rights:** It is important for you to know that your participation is entirely voluntary. You may decide to not take part in or decide to quit the study at any time, without any penalty. You may decide to make comments off-the-record, and the moderator will turn the tape recorder off for that part of the conversation. You will be told about any new information or changes in the study that might affect your participation.

**Procedures:** Your participation in the project will last between approximately between 30 and 60 minutes. Individual interviews will be conducted in a place of your choice. All interviews will be tape recorded and transcribed by an independent transcriber experienced in qualitative research. Information shared in this study will be used as the main data collection. The data will be used in final reports, journal publications, and at conferences.

**Alternatives:** At any time, you may decide to not participate in this study. You may also decide to comment off-the-record by requesting the moderator to turn off the tape recorder.

**Risks:** There are minimal risks attached to this study. It is possible, although not likely, that you may feel threatened by a question or have a concern about confidentiality. Your interview responses will be

kept confidential, available only to Ms. Piorun for analysis purposes. If the length of the interview is inconvenient for you or you feel discomfort at any time, you may end the session without any consequence.

**Benefits:** Although there is no direct benefit to you for participating in this study, your participation will likely benefit the research field in university research libraries.

**Costs:** There are no direct costs to you, other than your time spent during the interview process.

**Confidentiality:** All information will be confidential to the extent possible by law. In all records of the study, you will be identified by a code number and your name will be known only to the researcher(s). Personal information will never be shared with anyone outside of this research study and will not be used in any reports or publications. All information stored electronically (digital files) is password protected and transcripts are kept in a locked cabinet. Only the principal investigator and transcriber will have access to research materials. All materials including the digital files and transcripts will be destroyed 3 years after the study is completed.

**Voluntary Participation:** Participation is voluntary. If you agree to be in this study, but later change your mind, you may withdraw at any time. There are no consequences of any kind if you decide you do not want to participate.

**Questions:** Please feel to ask any questions you may have about the study or about your rights as a participant. If other questions occur to you later, you may call me, the investigator, Mary Piorun at 508/856-2206 or e-mail to [mary.piorun@umassmed.edu](mailto:mary.piorun@umassmed.edu). If at any time during or after the study you would like to discuss the study or your research rights with someone who is not associated with this research study, you may contact the Human Protections Administrator of the Simmons College IRB, 617-521-2414

☐ I agree to participate in this research study.

☐ I agree to be recorded

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Participant's Name

---

Date

---

Participant's Signature

---

Researcher's Signature

---

Date

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